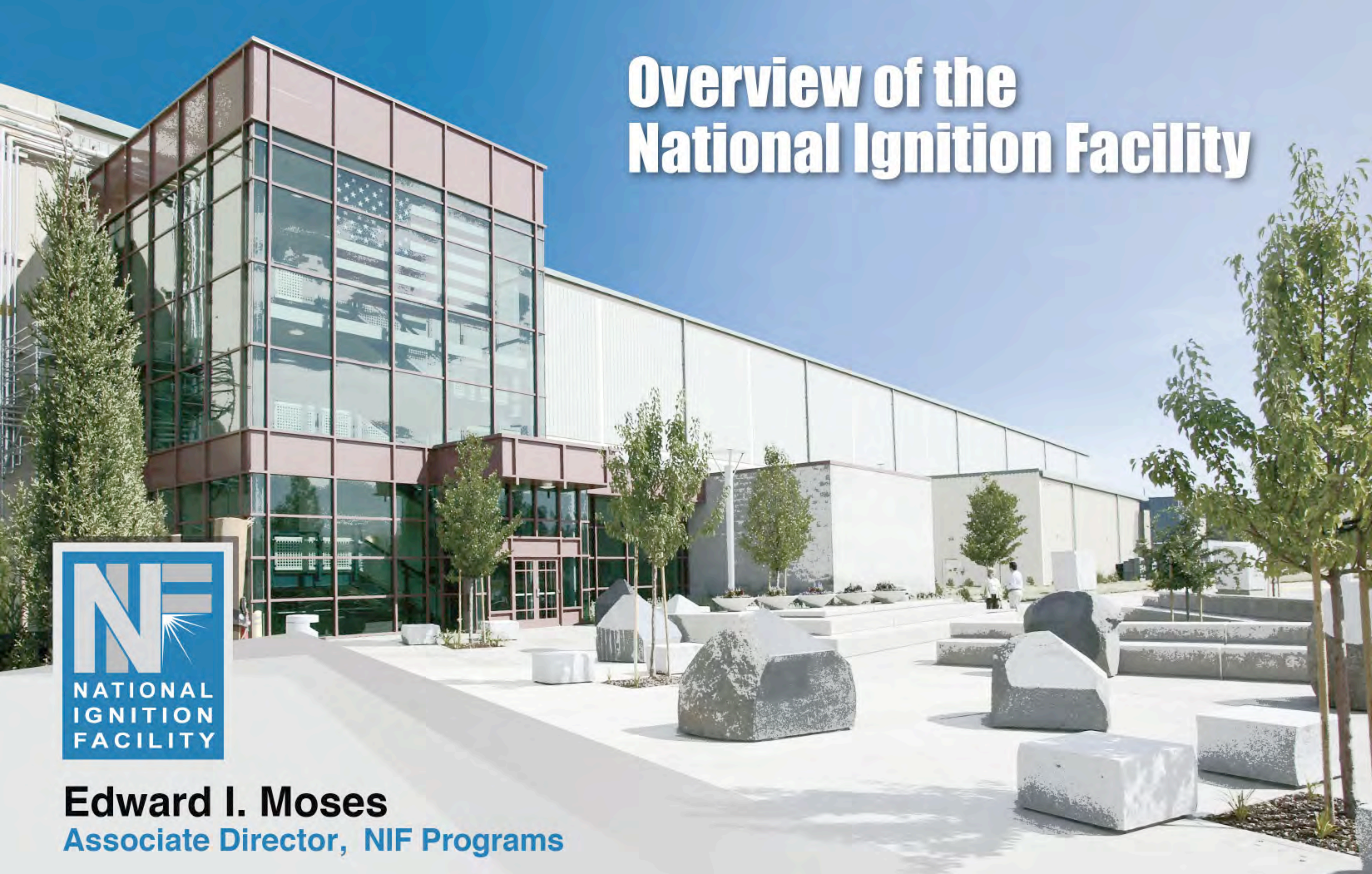


Overview of the National Ignition Facility

NIF
NATIONAL IGNITION FACILITY

Edward I. Moses
Associate Director, NIF Programs

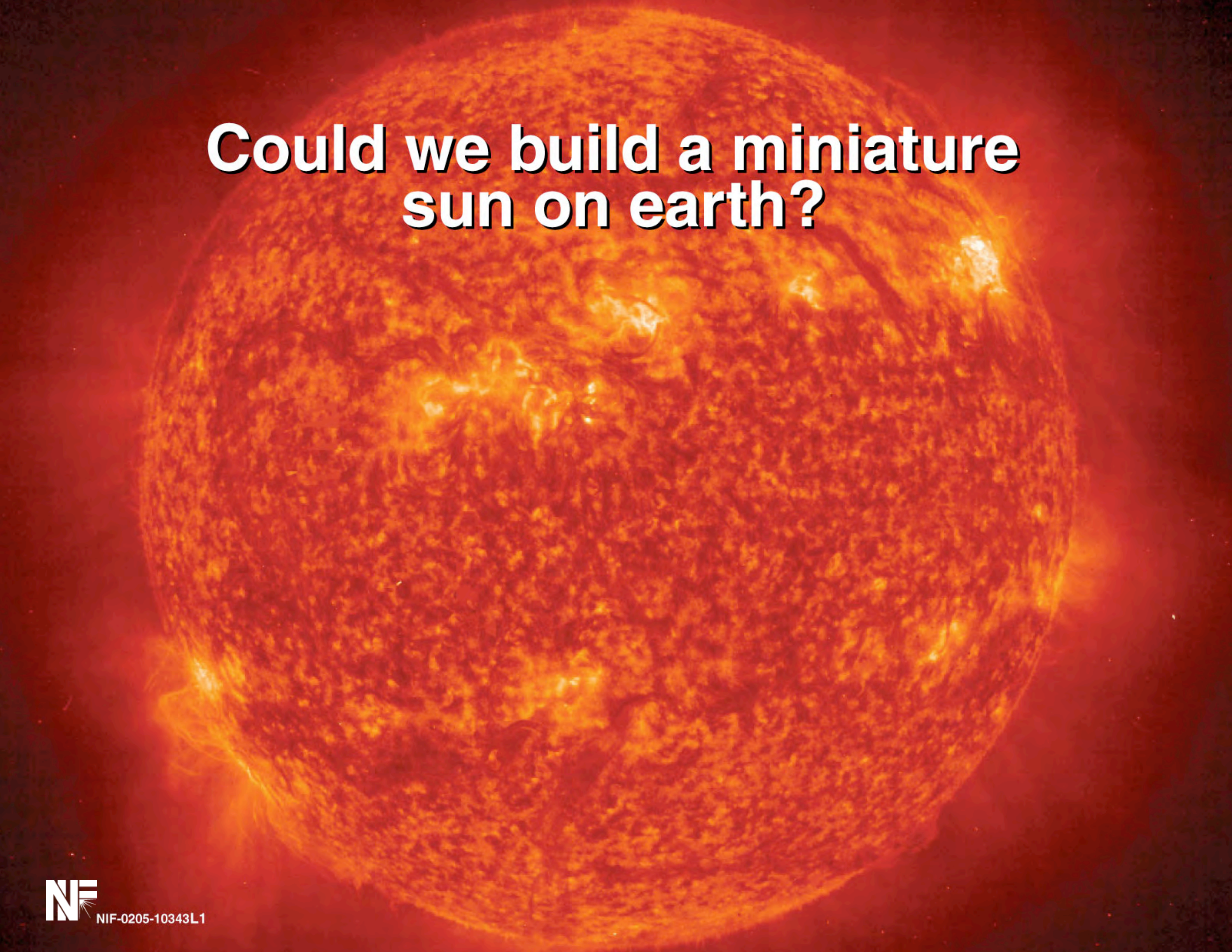
Presentation of the NIF Nuclear Astrophysics Workshop

Lawrence Livermore National Laboratory

August 27, 2007

Work performed under the auspices of the U.S. Department of Energy, National Nuclear Security Administration by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-ENG-48.

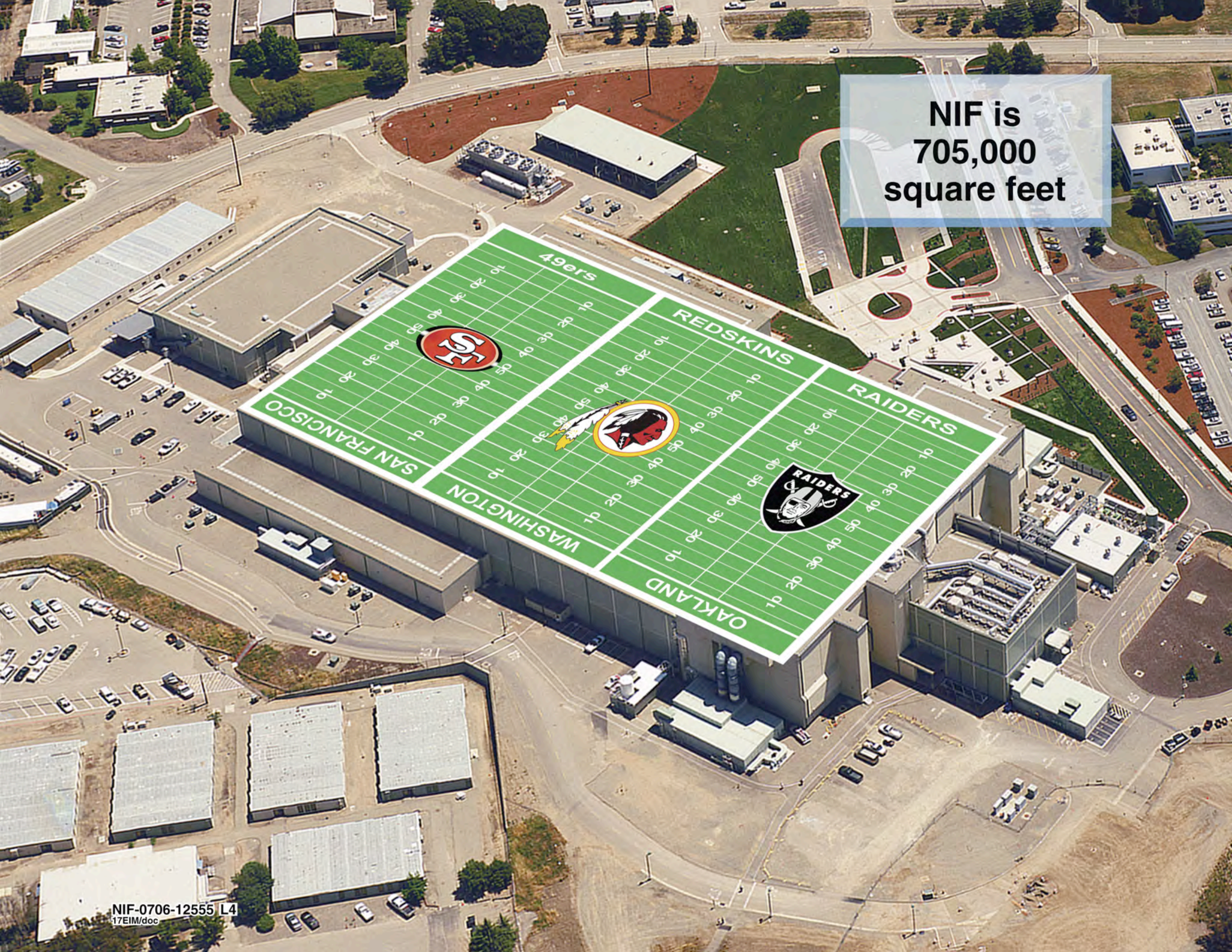
UCRL-PRES-234105


Could we build a miniature
sun on earth?
NIF-0205-10343L1

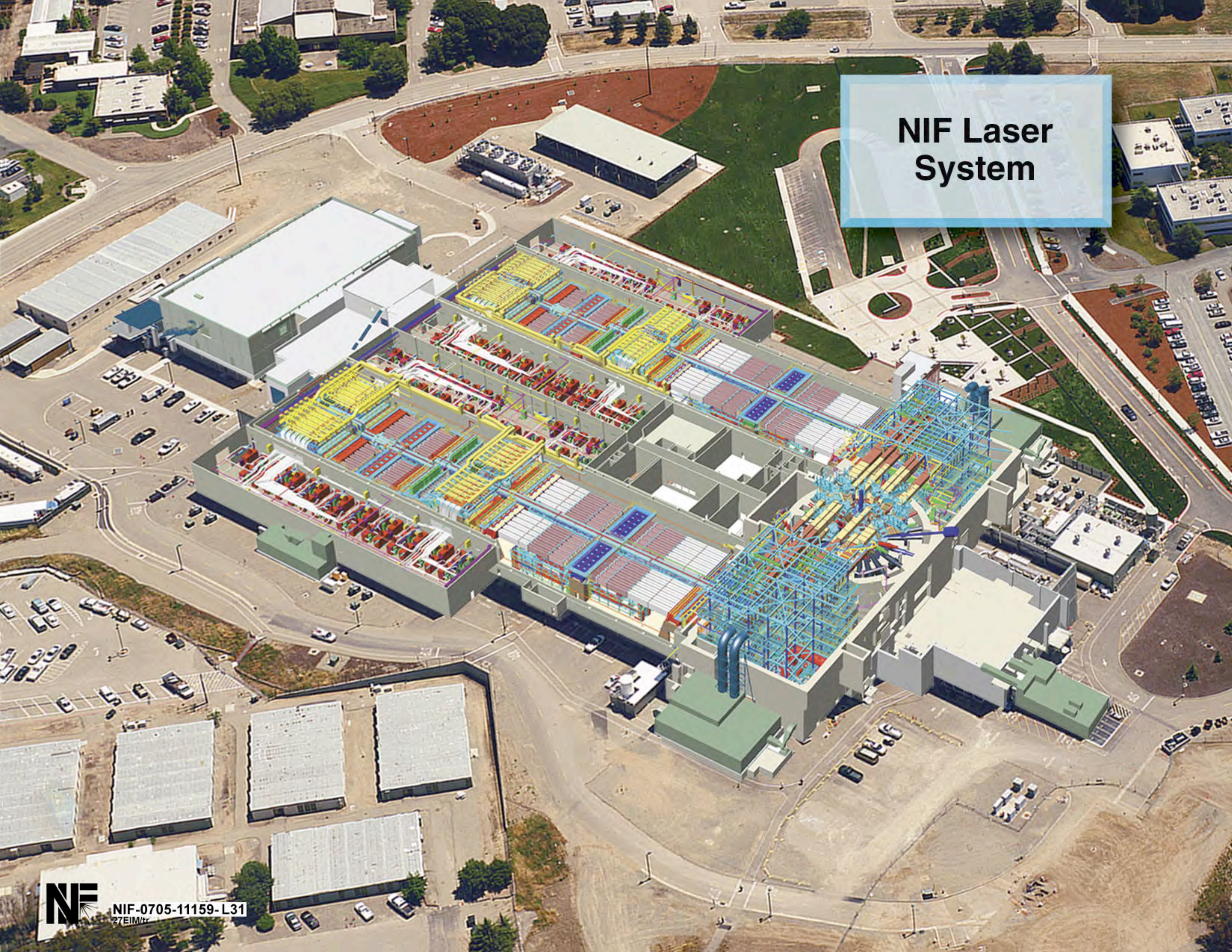
It seems likely!

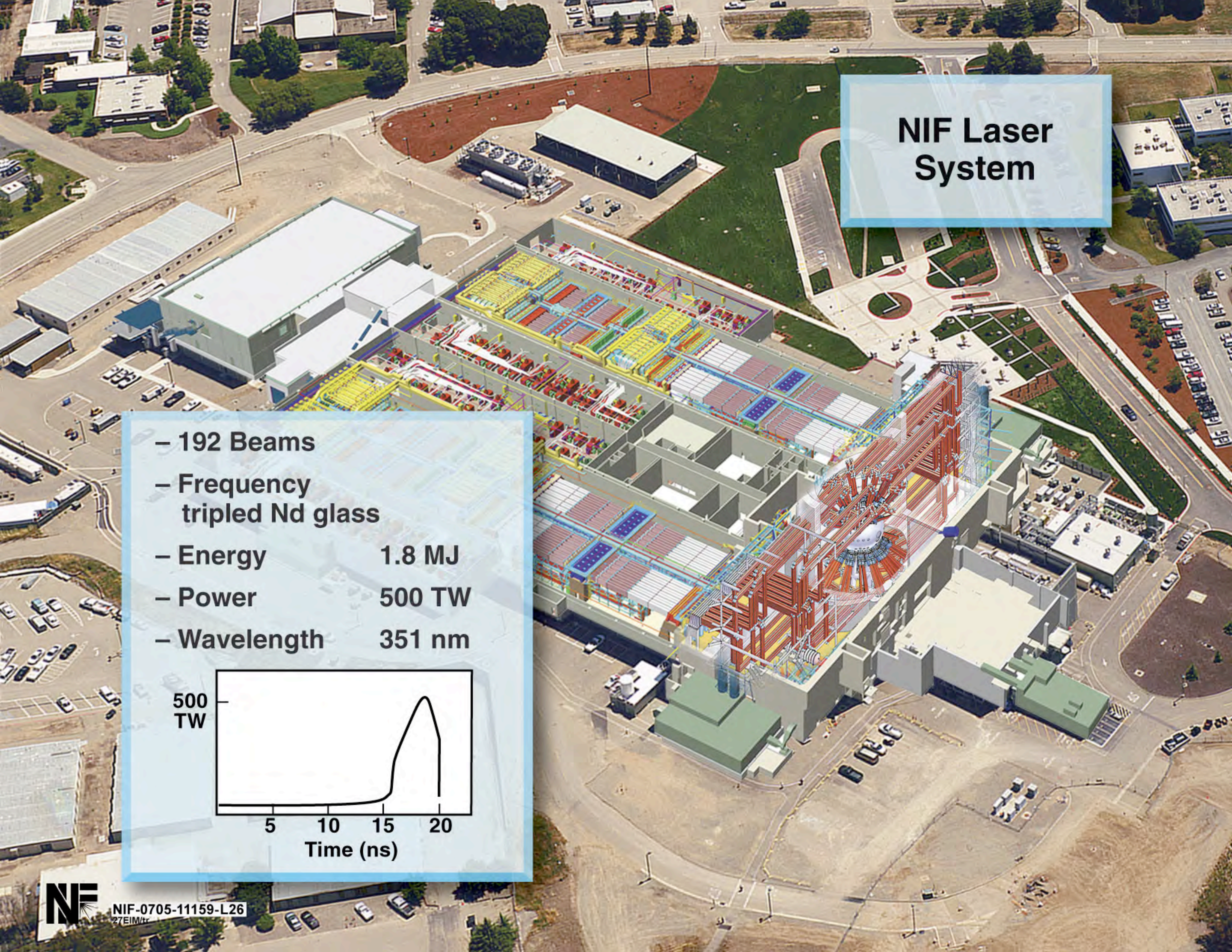

San Francisco
(45 mi.)
Lawrence Livermore National Laboratory
National Ignition Facility
NIF-0605-10997-L47
27EIM/cld

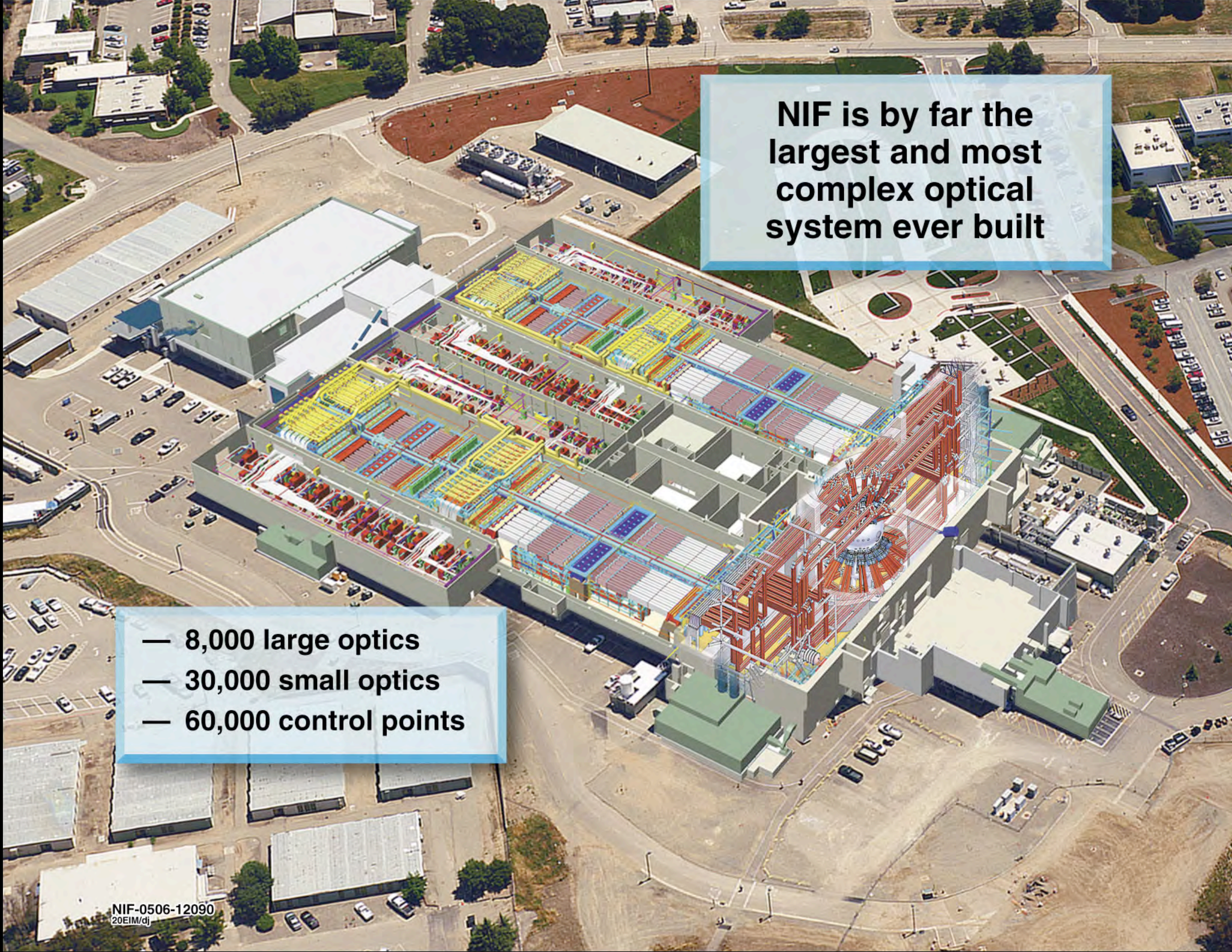

National Ignition Facility
NIF-0705-11159-L20
27EIM/tr

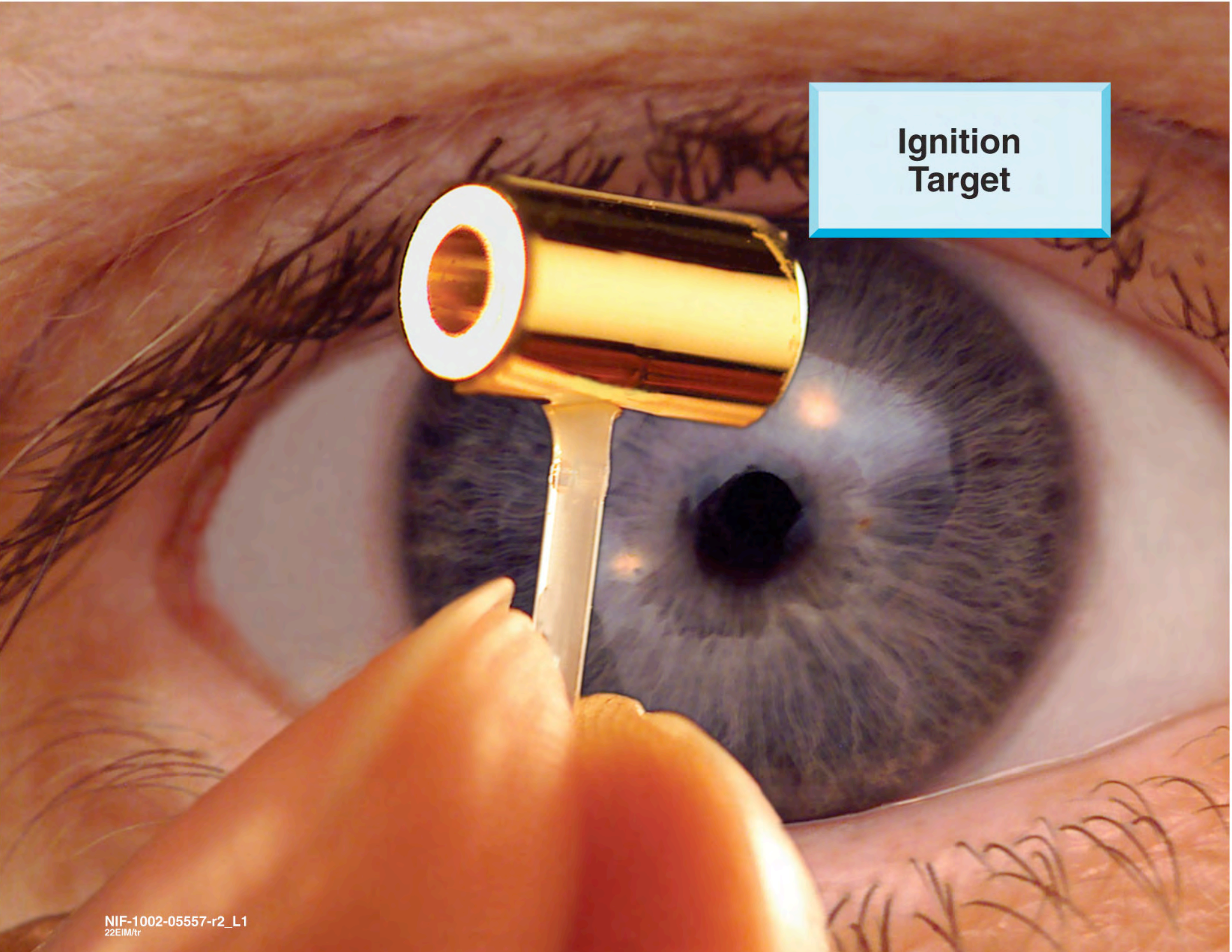

NIF is
705,000
square feet
49ers
SAN FRANCISCO
REDSKINS
WASHINGTON
RAIDERS
OAKLAND
NIF-0706-12555 L4
17EIM/doc

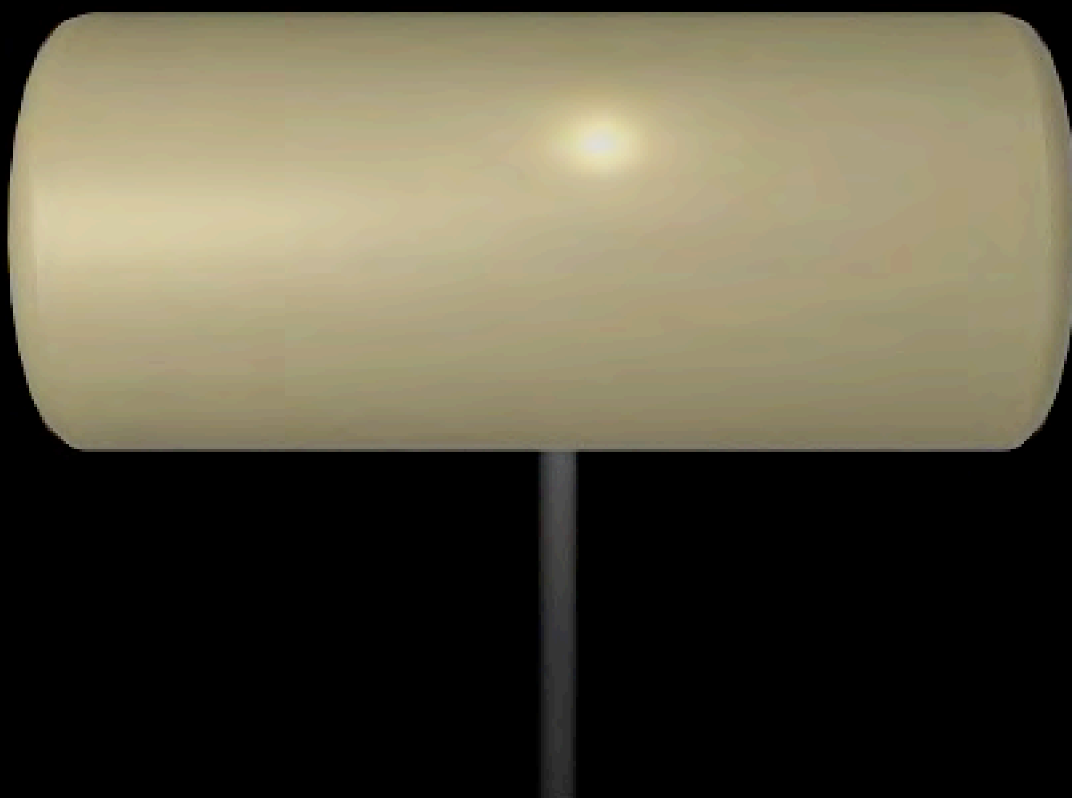

NIF is
70,000
square meters
NIF-0705-11159 L30
27EIM/tr


NIF Laser System
NIF-0705-11159-L31
27EIM/tr


NIF Laser System
– 192 Beams
– Frequency tripled Nd glass
– Energy 1.8 MJ
– Power 500 TW
– Wavelength 351 nm
500 TW
5
10
15
20
Time (ns)
NIF-0705-11159-L26
27EIM/tr


NIF is by far the largest and most complex optical system ever built
— 8,000 large optics
— 30,000 small optics
— 60,000 control points
NIF-0506-12090
20EIM/dj

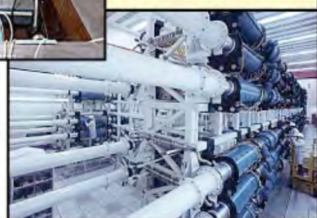

Ignition
Target
NIF-1002-05557-r2_L1
22EIM/tr



NIF appears to be the culmination of a long line of glass laser systems

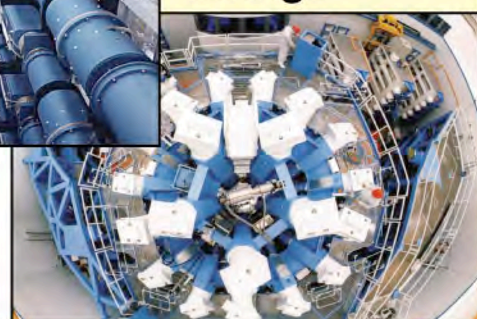
Janus 100J IR

Shiva 10kJ IR

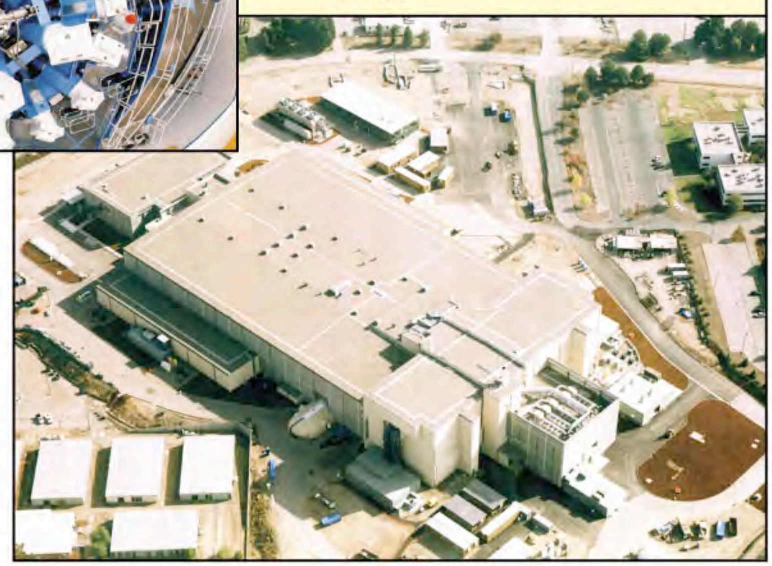


Nova 30kJ UV

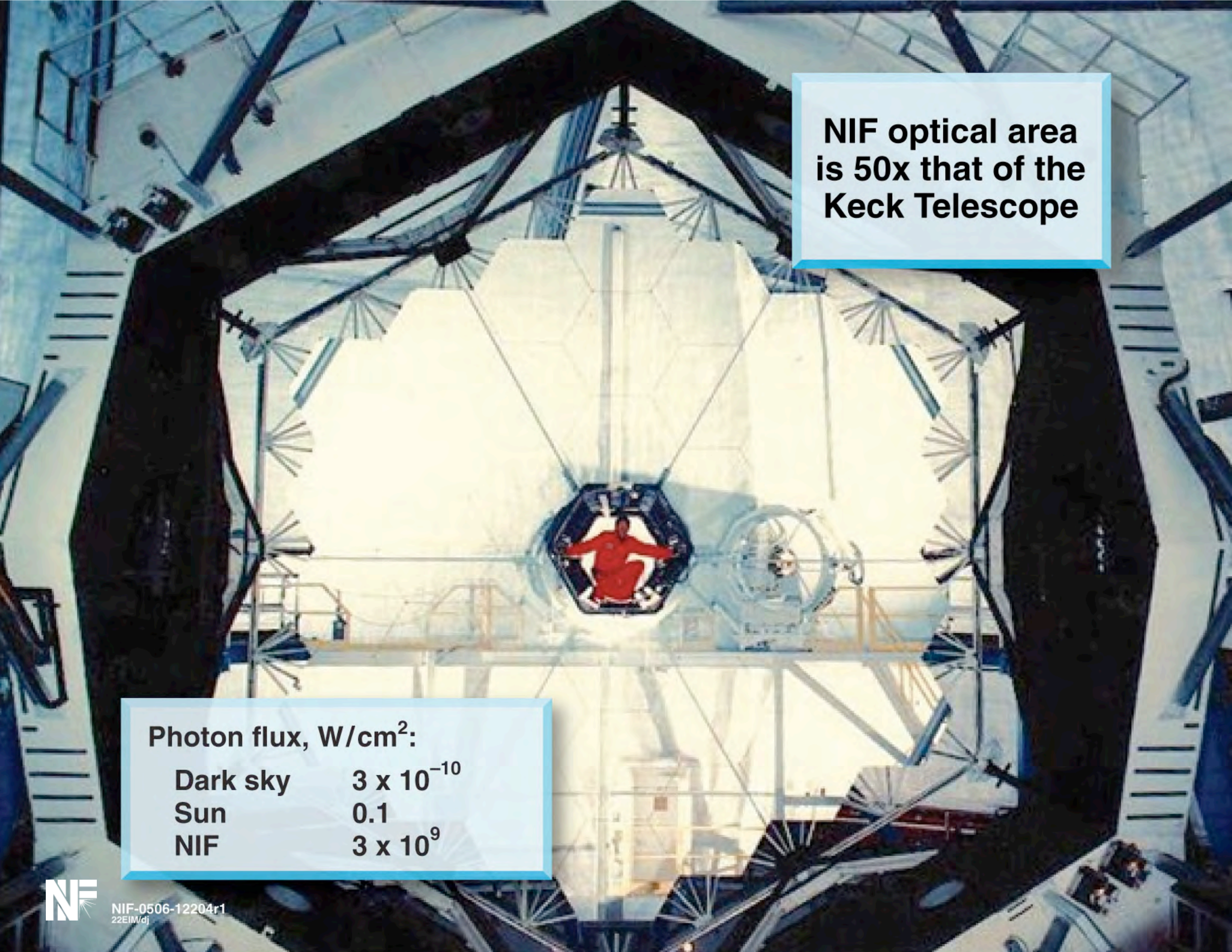
Omega 25kJ UV

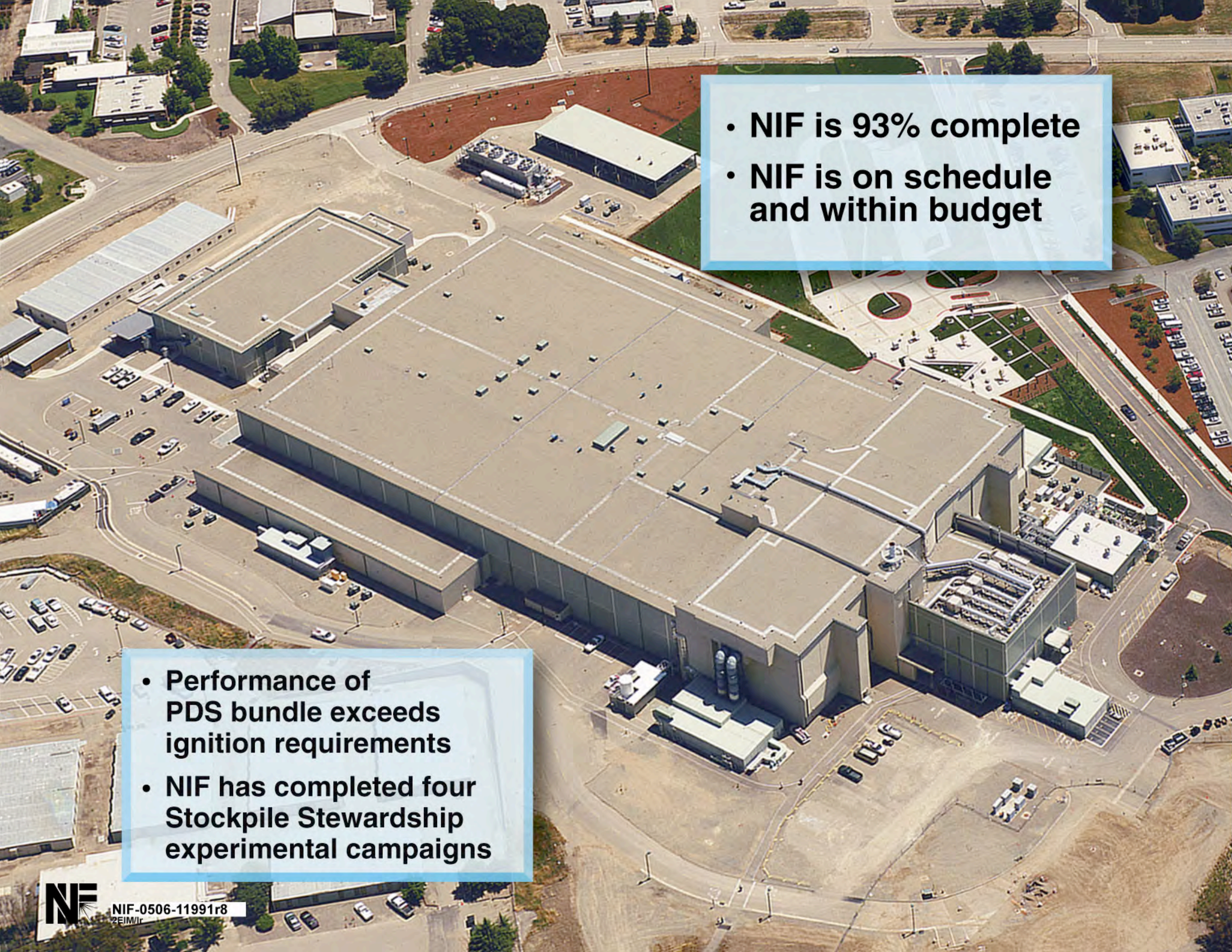


NIF 1.8MJ UV

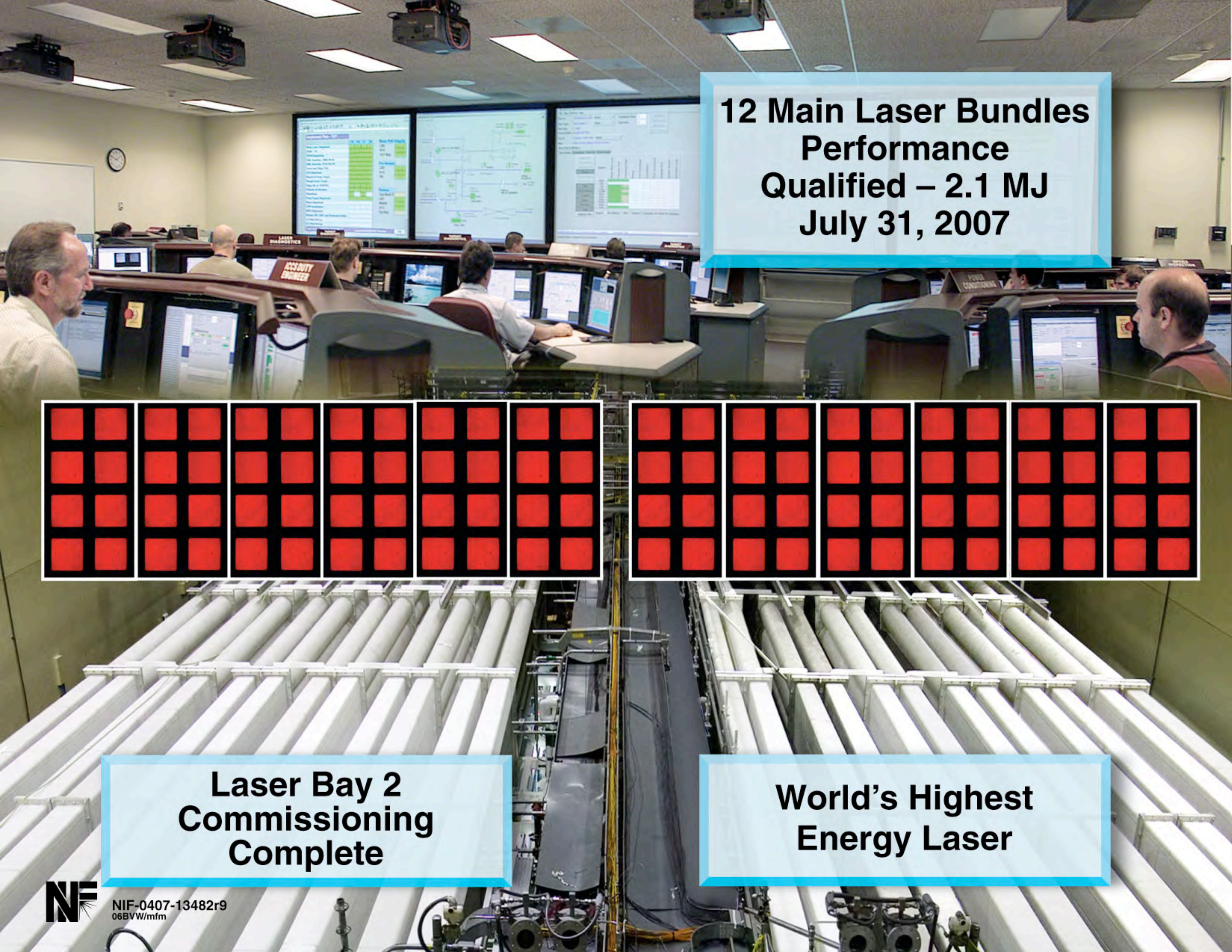


NIF is designed to meet all mission requirements


NIF optical area is 50x that of the Keck Telescope
Photon flux, W/cm^2:
Dark sky 3×10^{-10}
Sun 0.1
NIF 3×10^{9}
NIF-0506-12204r1
22EIM/dj


• NIF is 93% complete
• NIF is on schedule and within budget
• Performance of PDS bundle exceeds ignition requirements
• NIF has completed four Stockpile Stewardship experimental campaigns
NIF-0506-11991r8
2EIM/lr

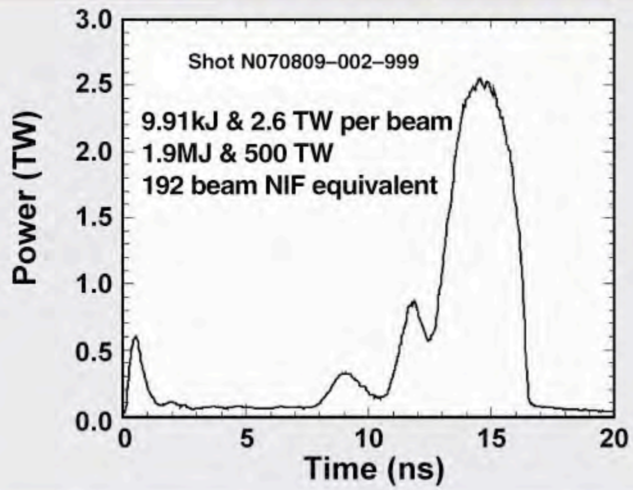

Laser Bay 2
25/21
40-60-0500-2429#13-r1_L1
P6294


12 Main Laser Bundles Performance Qualified – 2.1 MJ July 31, 2007
Laser Bay 2 Commissioning Complete
World's Highest Energy Laser
NIF-0407-13482r9
06BVW/mfm

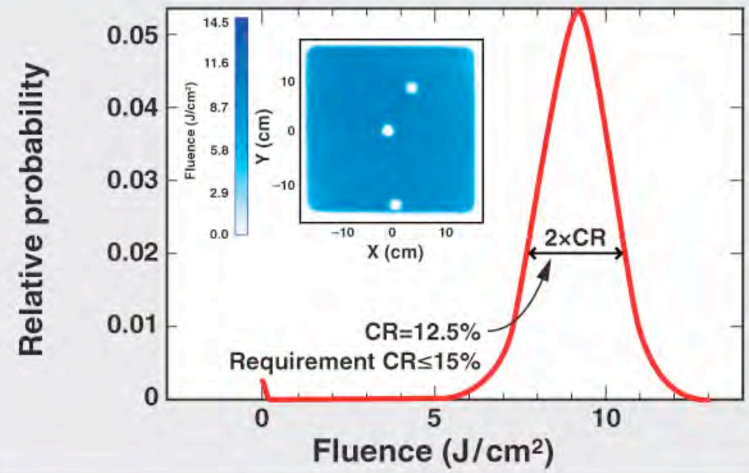
NIC 1.8 MJ ignition point design, energy, power, pulse shape & smoothing were achieved simultaneously

The National Ignition Campaign

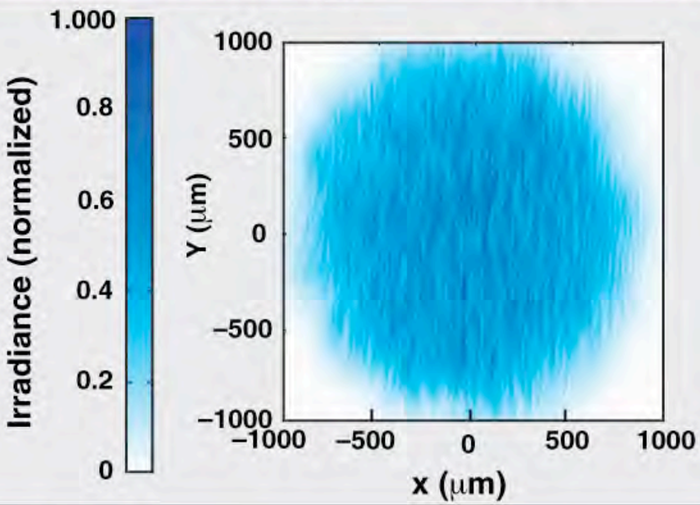
3ω Pulse Shape (500 TW)



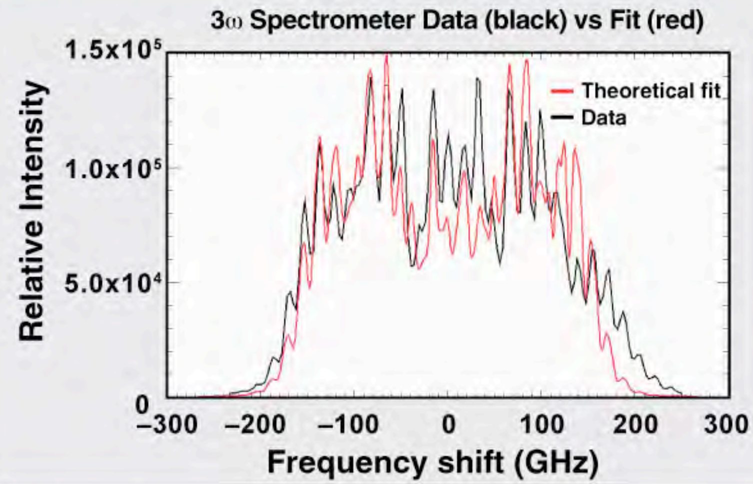
3ω Near Field Profile



3ω Focal Spot (1.91 × 1.64 mm^2)



3ω SSD Bandwidth (270 GHz)



>20 shots at full energy have been demonstrated

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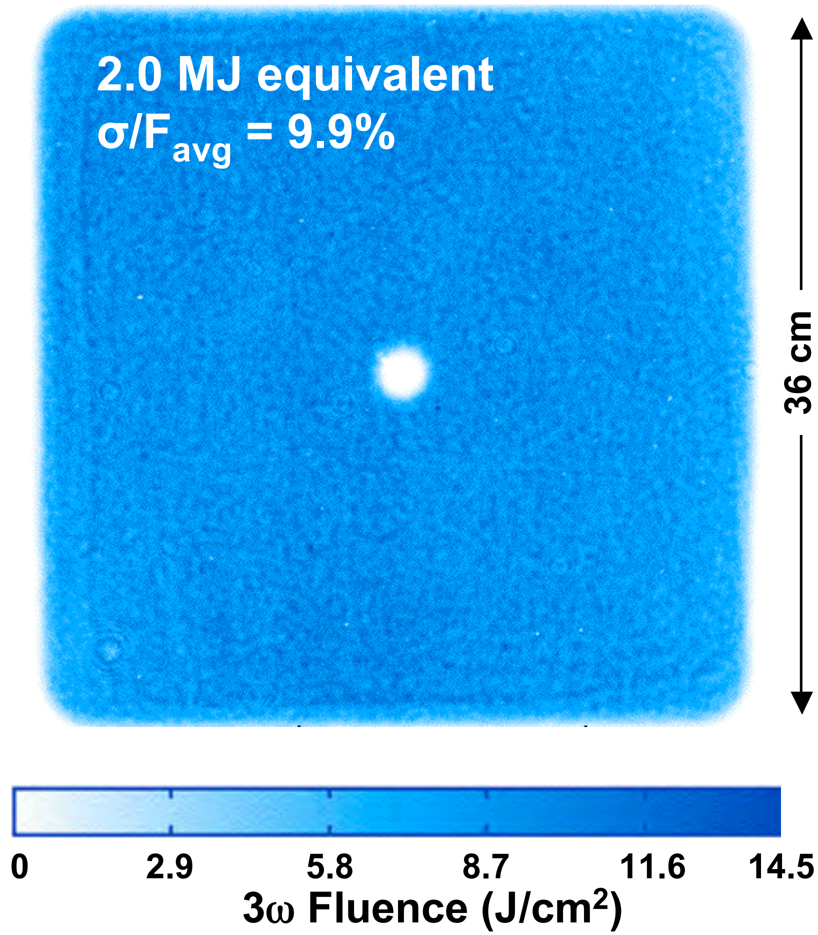
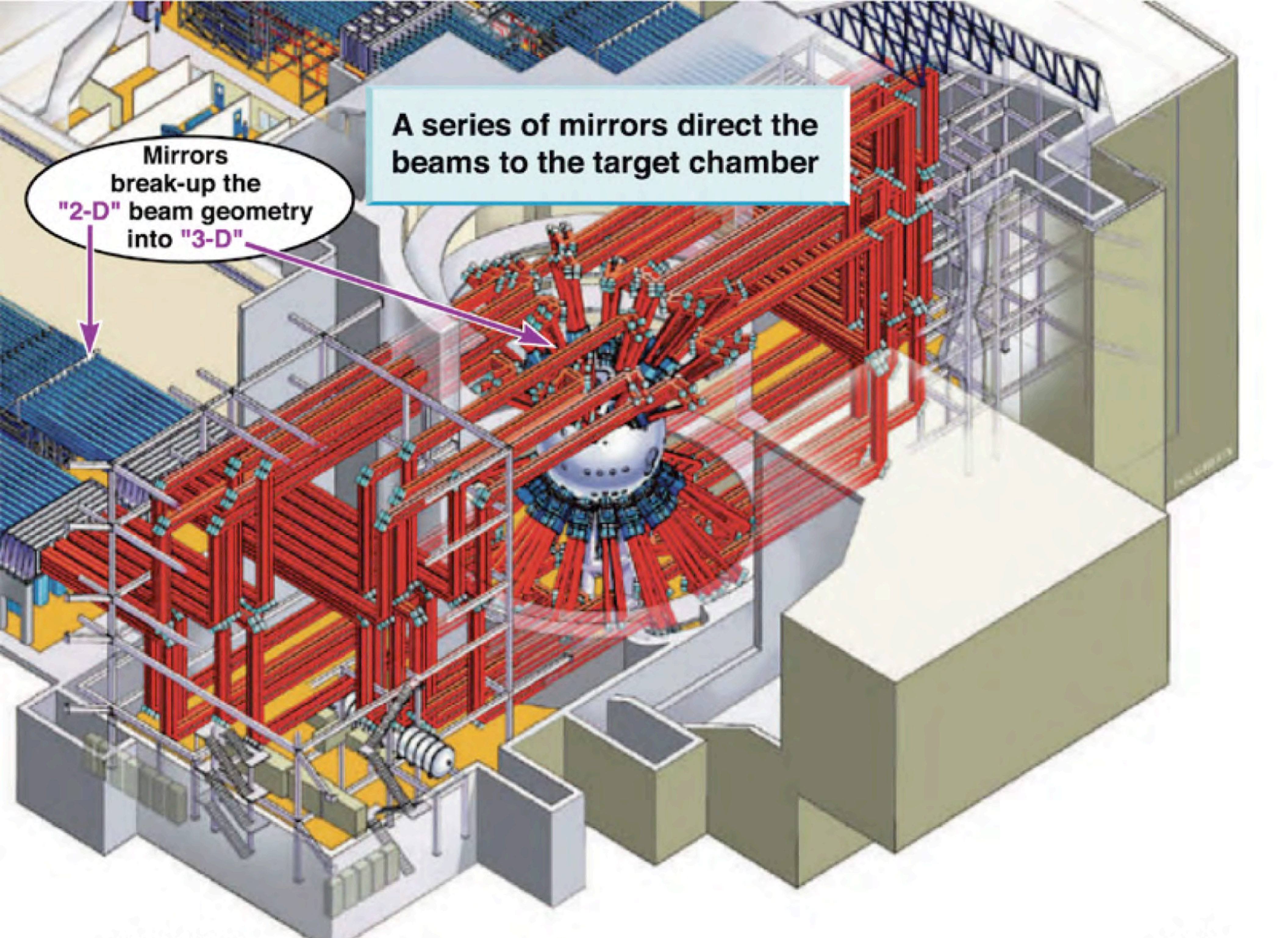
Final Focus lens after 11 shots at > 1.6 MJ

Shot N060329–003–999 11^{th} shot at > 1.6 MJ



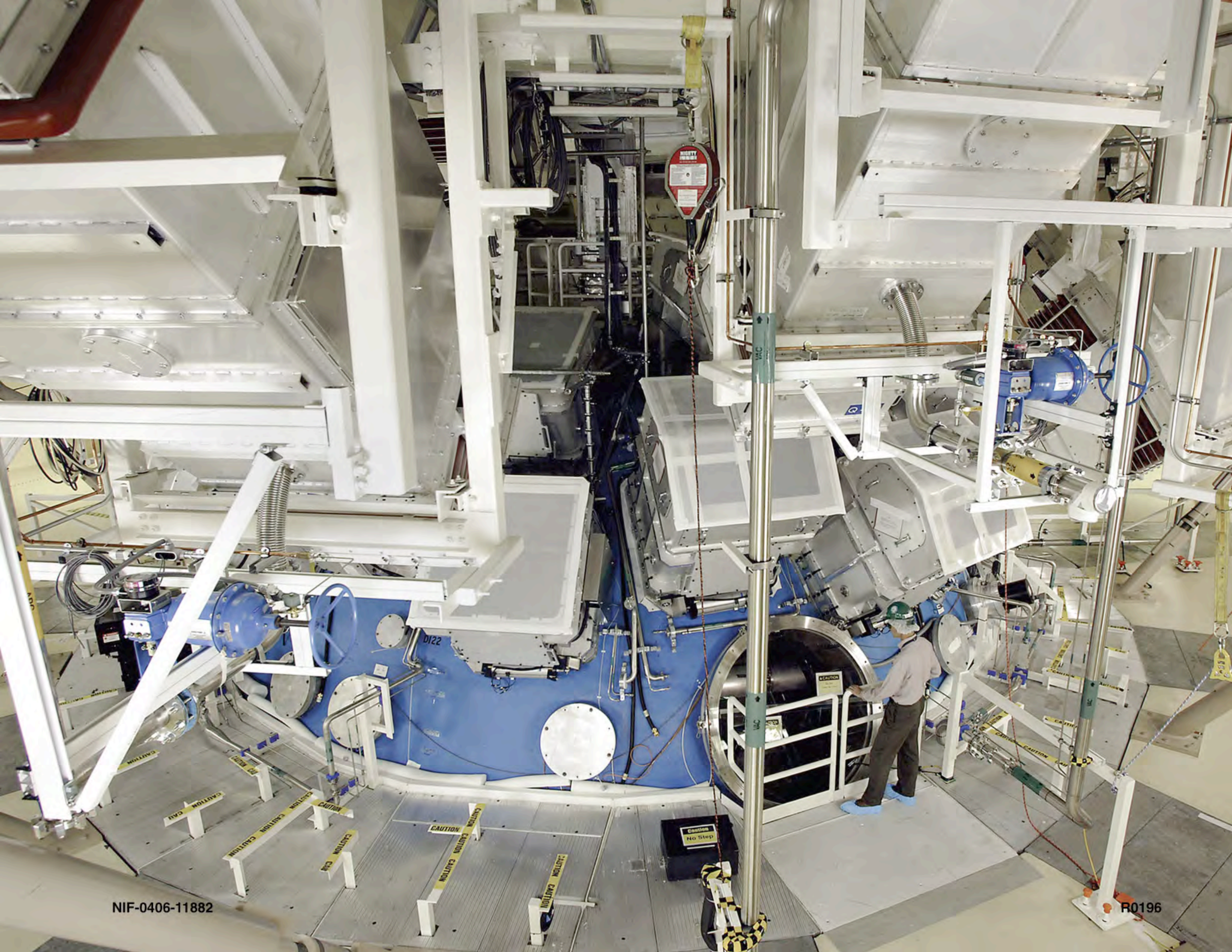

A series of mirrors direct the beams to the target chamber
Mirrors break-up the "2-D" beam geometry into "3-D"

NIF-0803-07131.ai
7EIM/cld

P5966

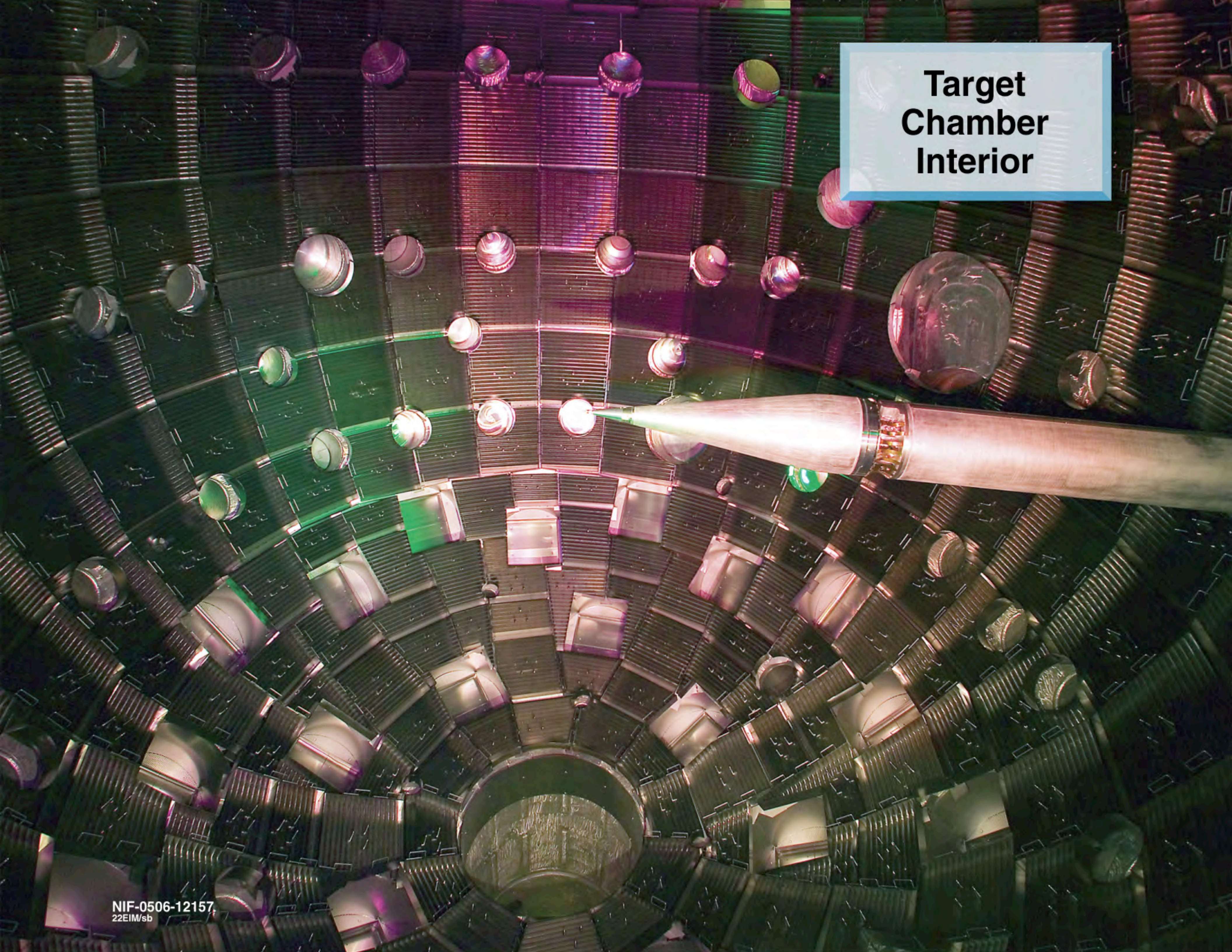

Switchyard 2
NIF-0105-10119r1
21EIM/paa

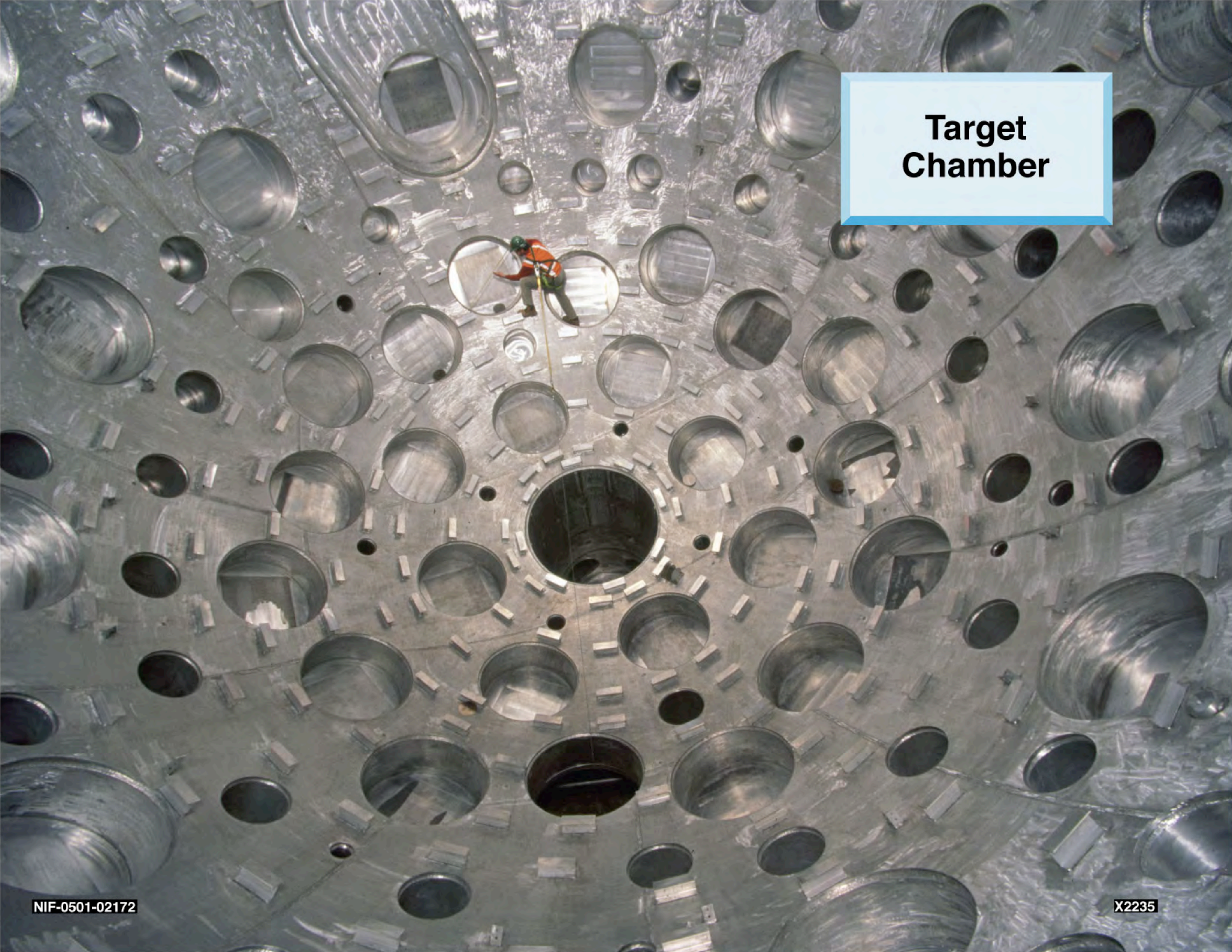

Target
Chamber
NIF-0105-10124
31EIM/dj
P8136



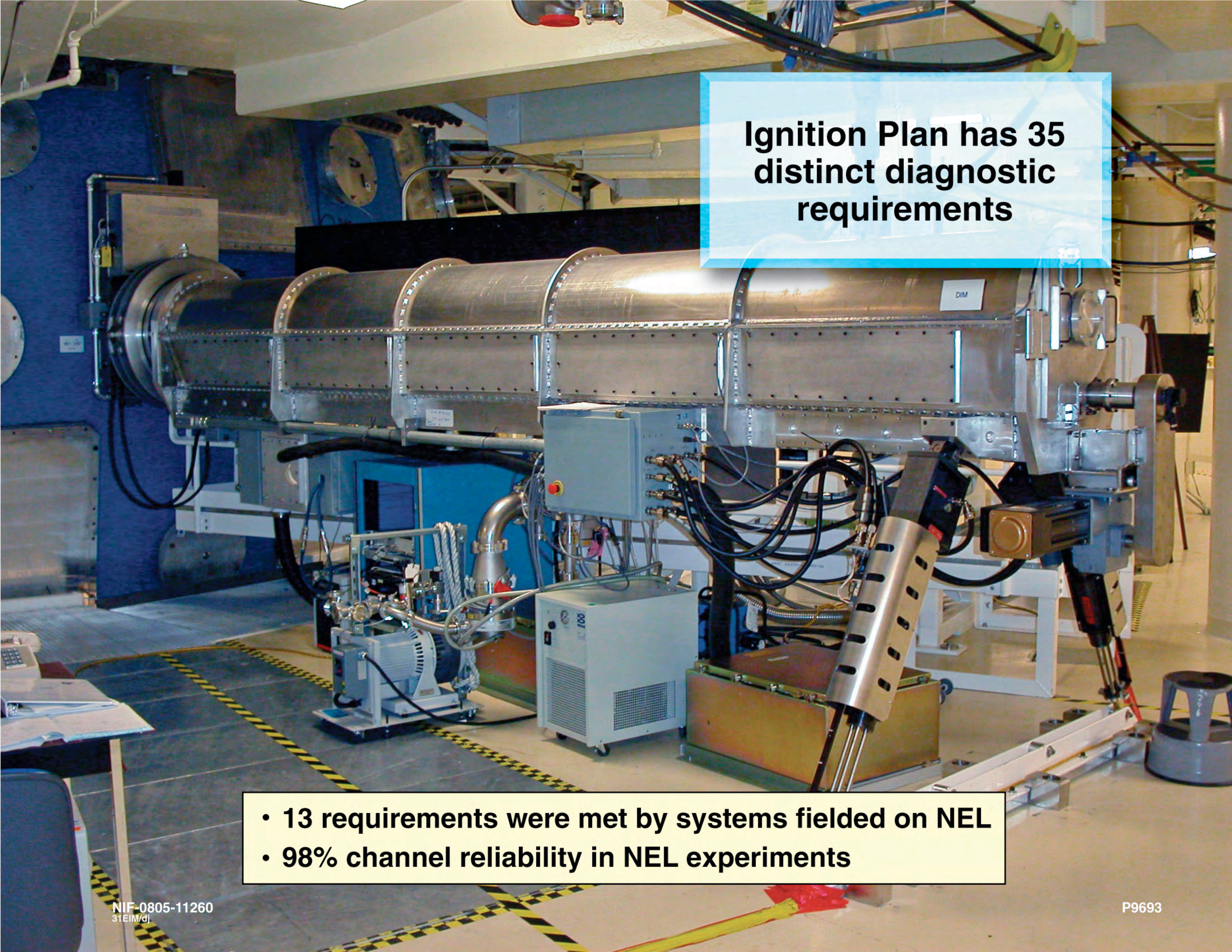
NIF-0406-11882

R0196


Target
Chamber
Interior
NIF-0506-12157
22EIM/sb

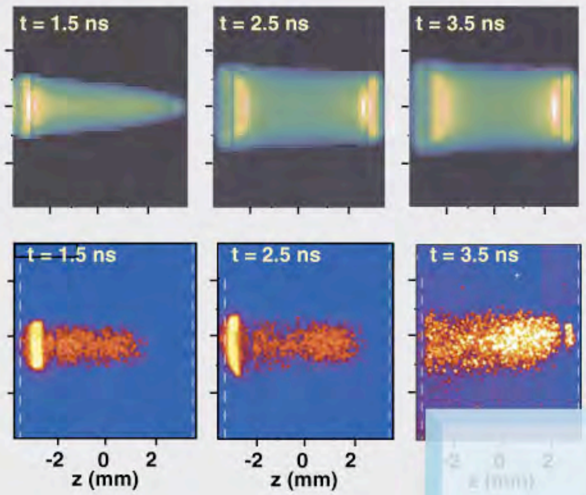

Target
Chamber
NIF-0501-02172
X2235

Ignition Plan has 35 distinct diagnostic requirements

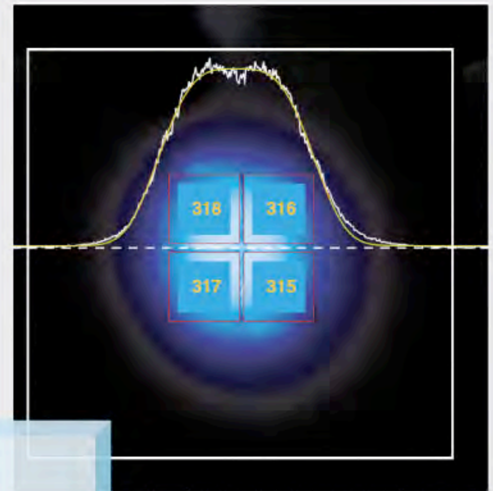


- 13 requirements were met by systems fielded on NEL
- 98% channel reliability in NEL experiments

LPI

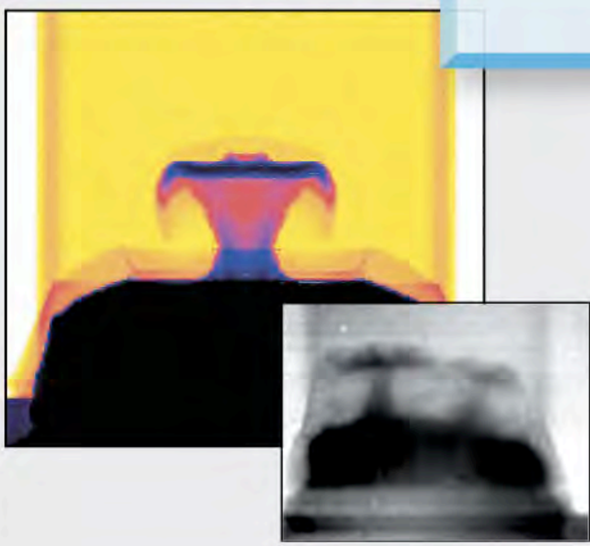


Hohlraums

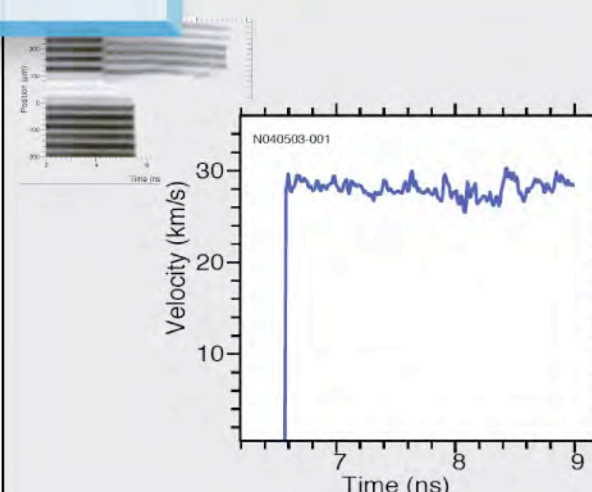


NIF is steadily developing a large range of experimental capabilities

Hydro



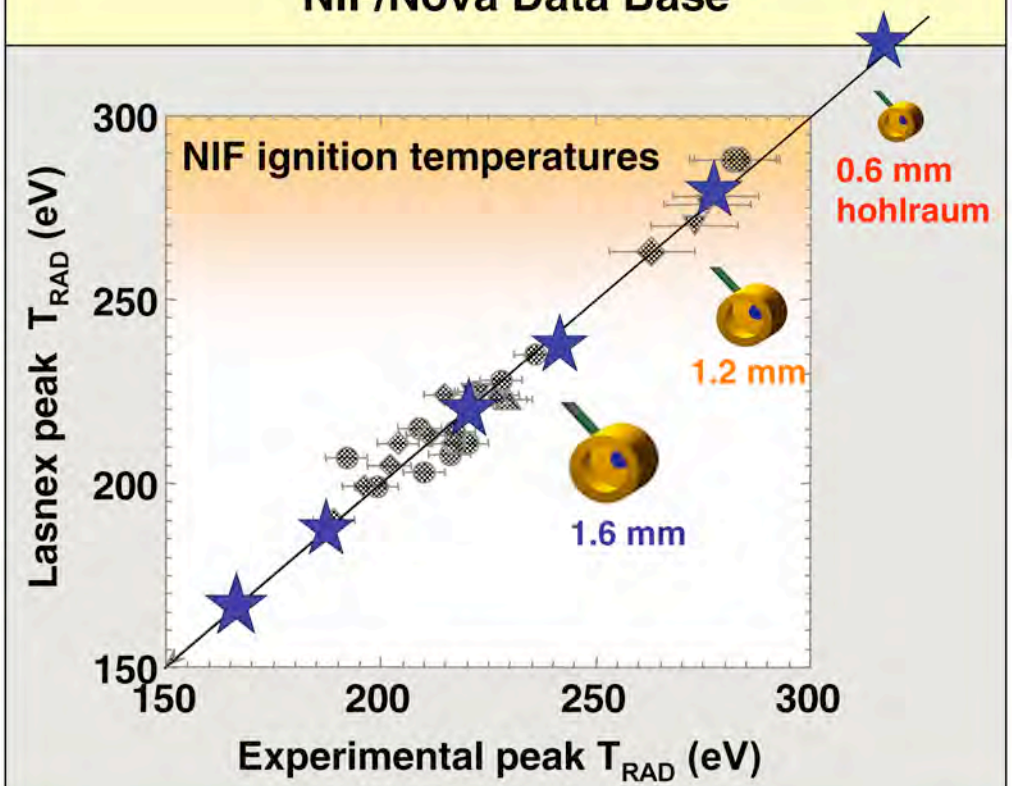
EOS



Our first hohlraum experiments on NIF have measured drive beyond the Nova data base (exceeding 300 eV)

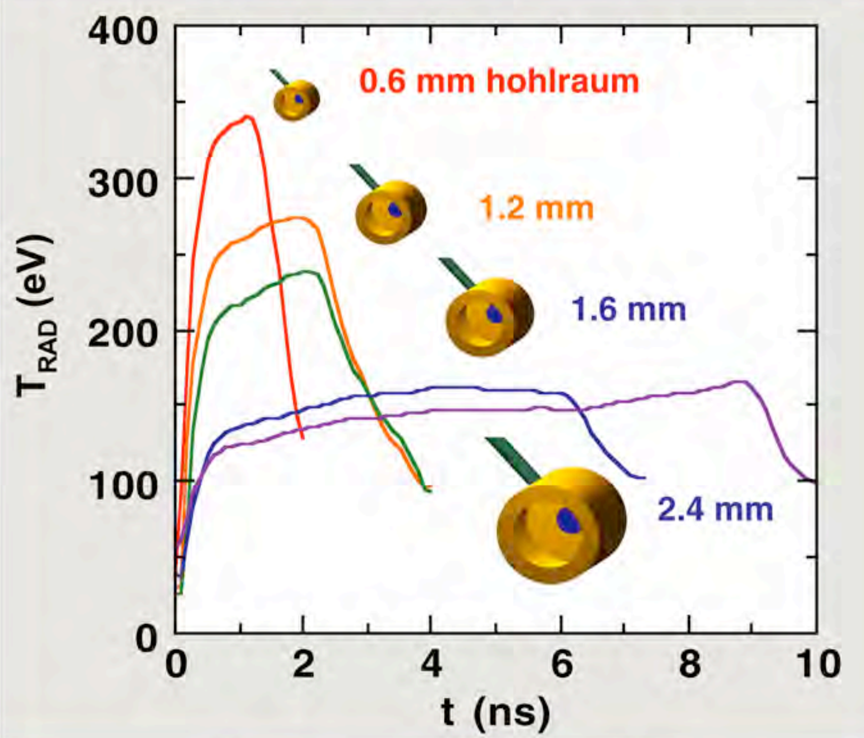
The National Ignition Facility

NIF/Nova Data Base



NIF experiments follow hohlraum drive scaling

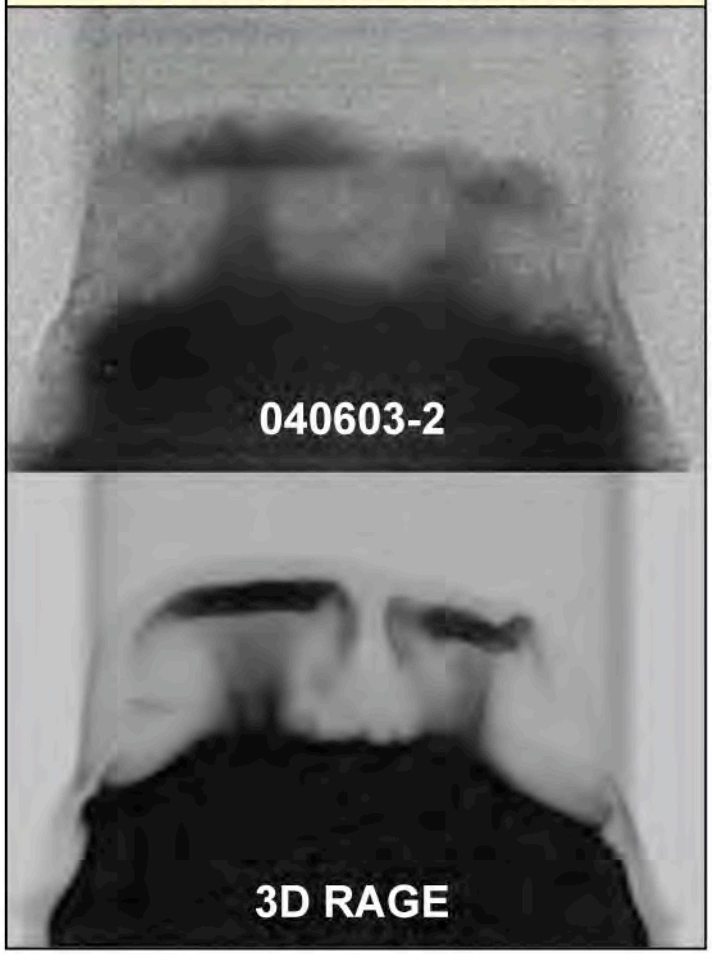
Hohlraum T_{RAD} vs Time



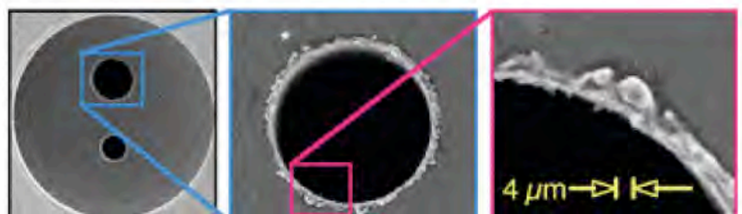
NIF experiments have explored new drive regimes

The complexities of the dual jet interaction challenge our modern hydrodynamics codes

Asymmetrical Dual Jets



- As part of NIF Hydro Campaign, LANL conducted dual jet experiments
- 3D RAGE simulations show many quantitative similarities with data
- However, smaller-scale details are not fully captured
- This is attributed to small scale target defects that break symmetry early in the jet's evolution

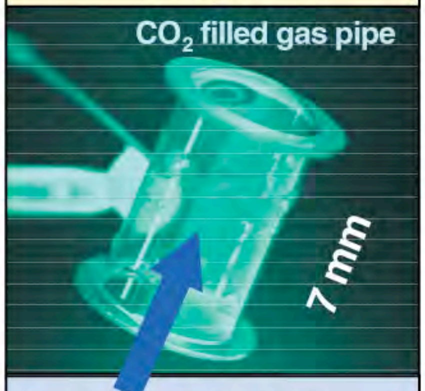


Scanning Electron Microscope (SEM) images show μm-sized defects that break symmetry and seed small-scale mixing

The first LPI experiments on NIF have demonstrated propagation in NIF ignition-scale plasmas

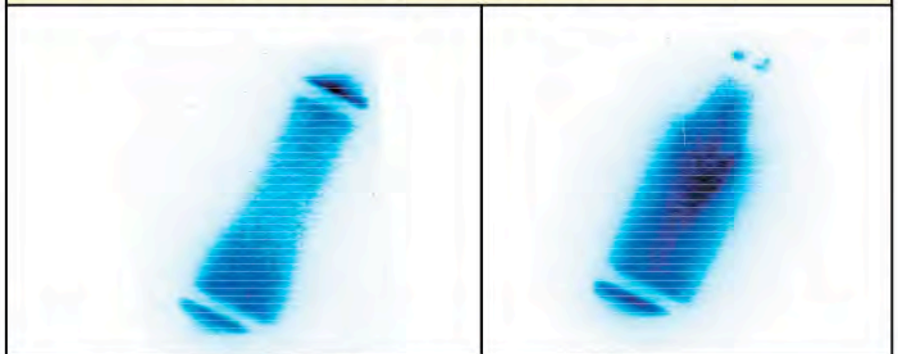
The National Ignition Facility

Target



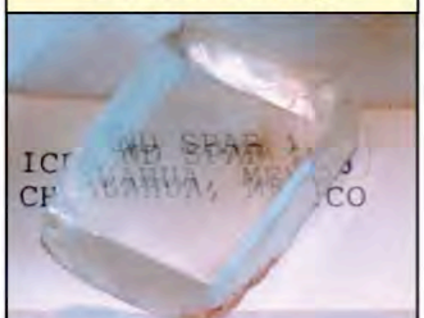
- 2.5×10^{15} W/cm^2
- 16 kJ in 3.5 ns
- 3ω

3 - 5 keV x-ray images at 3 ns



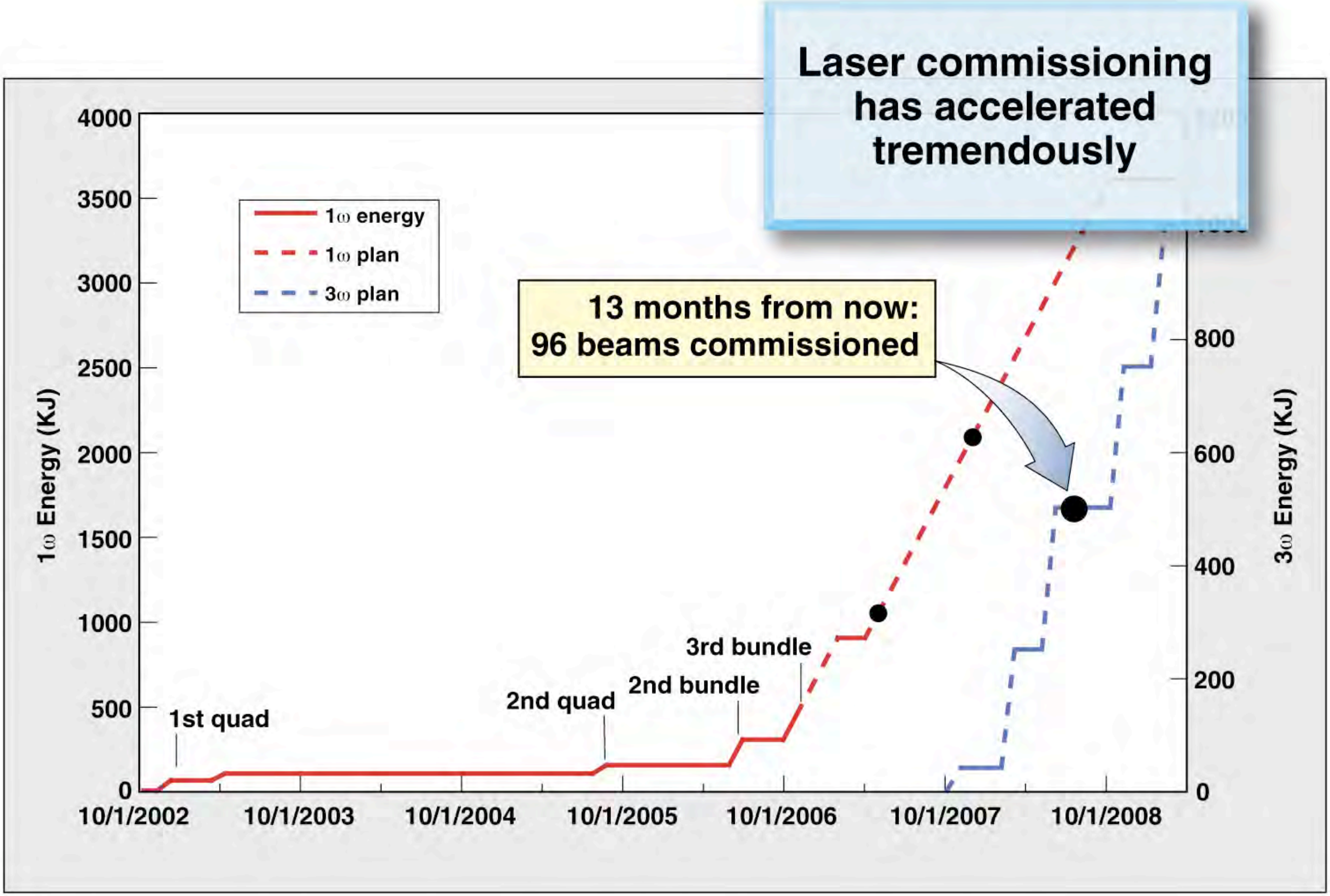
Phase plate, SSD, and Polarization wedges	Phase plate only (filaments)

Polarization Smoothing



Propagation improvement consistent with modeling and increase in filamentation threshold with improved beam smoothing (i.e., less power/speckle)

S. Glenzer (10186)
E. Dewald (This Session)



NIF-1006-12822r2–L2
11EIM/fm

Why Are We Building NIF?

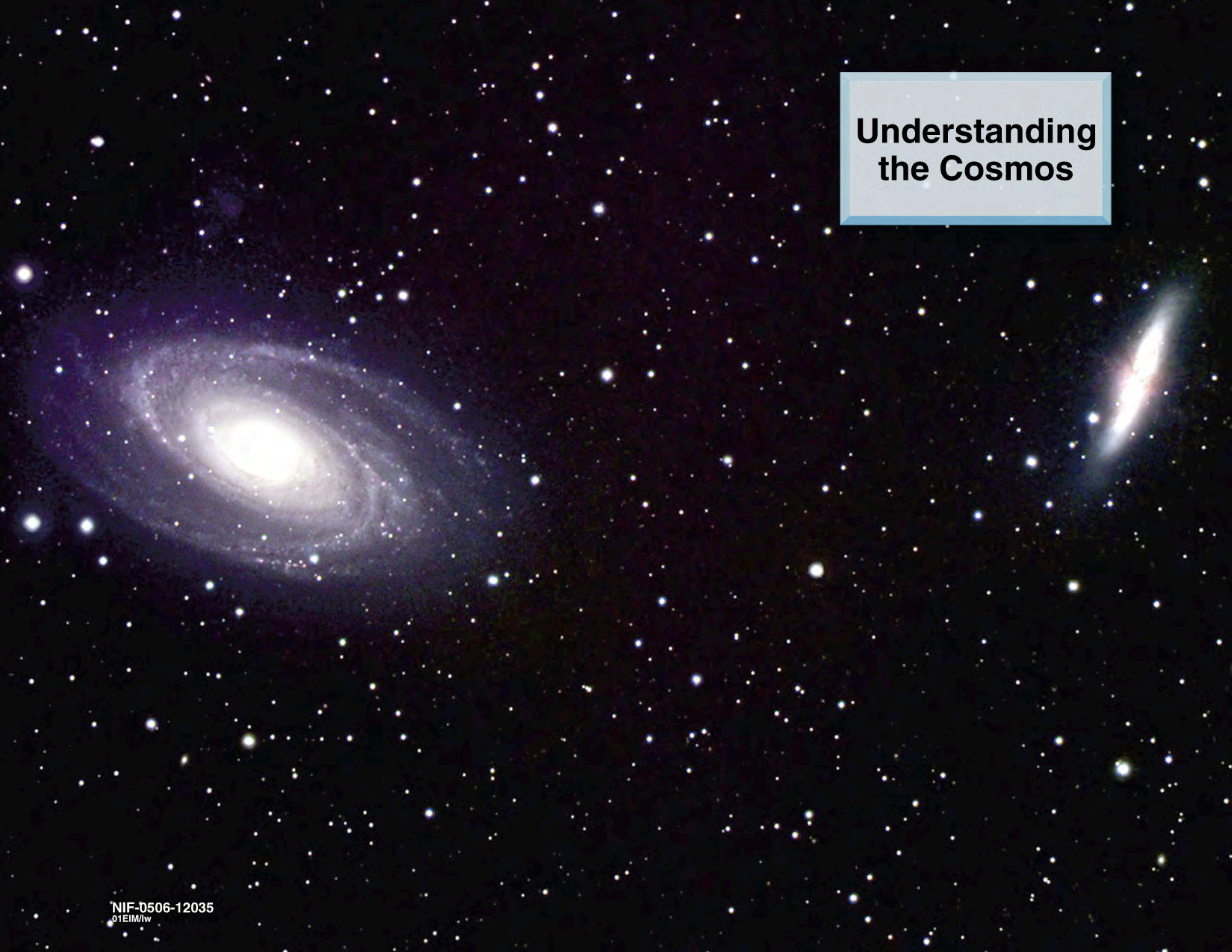
NIF-0506-12081
20EIM/mfm

Stockpile Stewardship

NIF-0805-11197
01EIM/dj

P9516

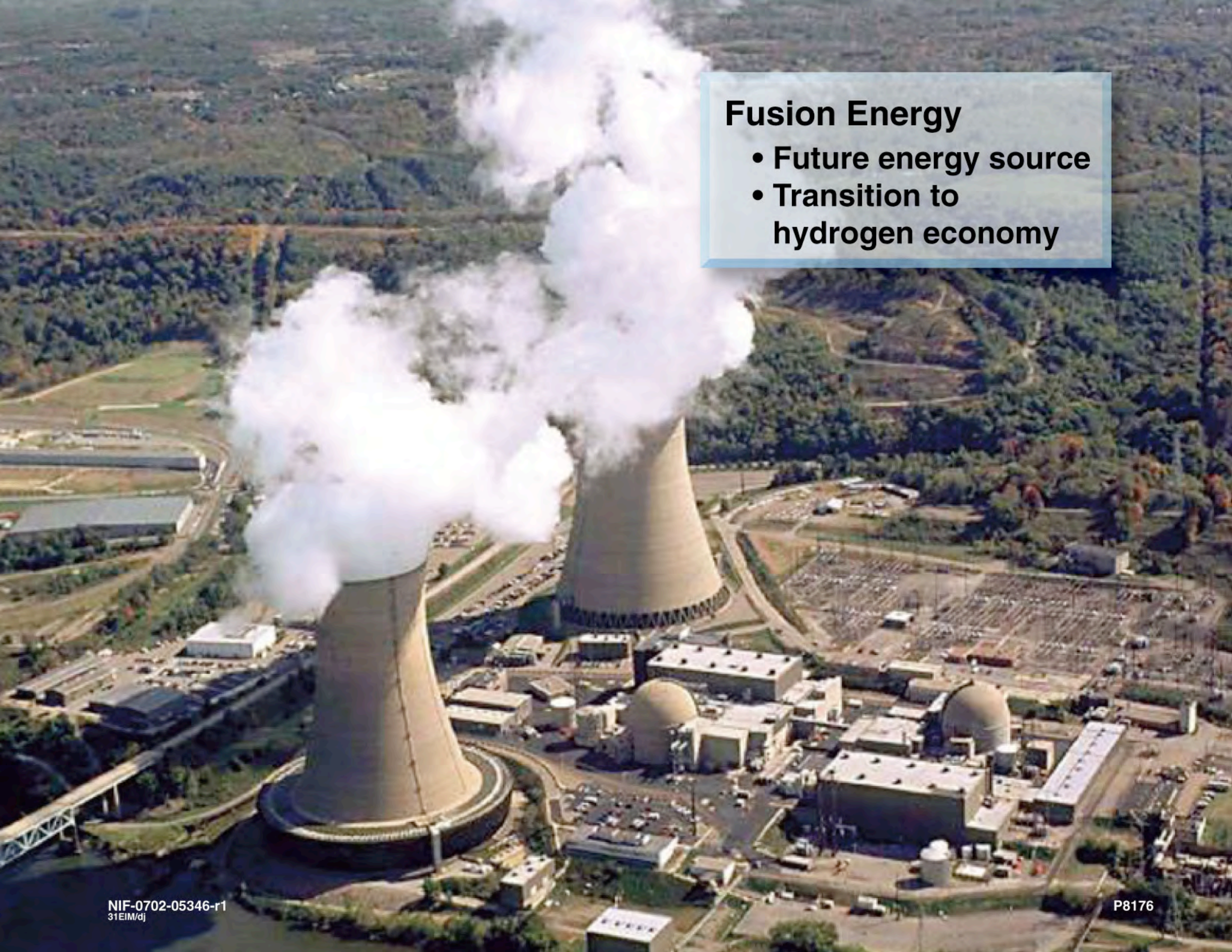
Understanding the Cosmos



NIF-0506-12035
01EIM/lw

Fusion Energy

- Future energy source
- Transition to hydrogen economy

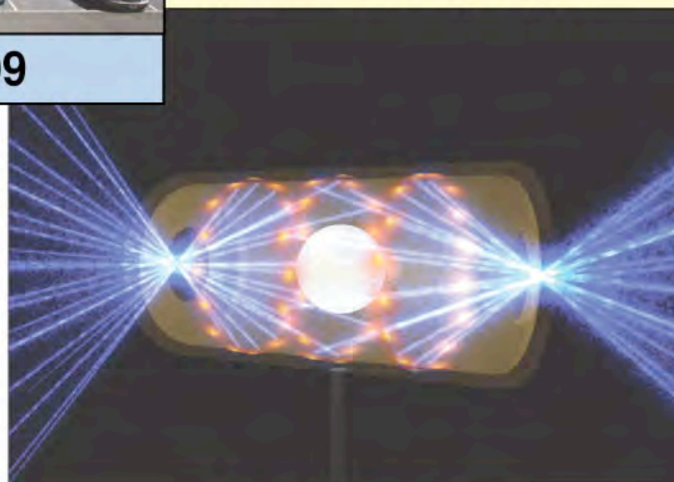


NIF Master Strategy

NIF Project

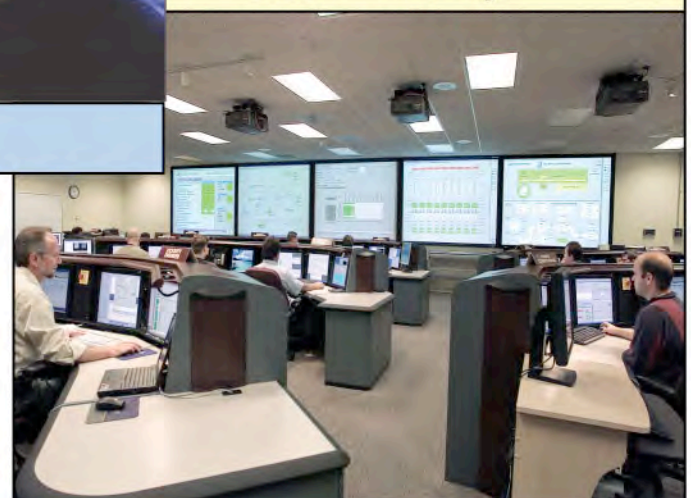
Completion in 2009

National Ignition Campaign



2006—2012

National User Facility



2009—2030

NIF-0506-12063r10_L1
20/geg

After 47 years, all of the pieces for ignition are nearly in place

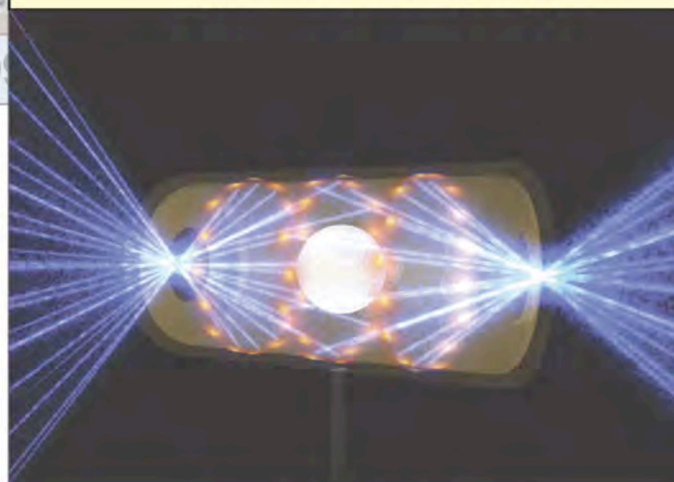
- The NIF laser and the equipment needed for ignition experiments, including high quality targets, will be available in 24 months
- We have an ignition point design target near 1 MJ with a credible chance for ignition during early NIF operations
- We have an Early Opportunity Shots (EOS) system commissioning campaign with 96 beams planned to start in 12 months
- The initial ignition experiments will only scratch the surface of NIF's potential, which includes high yields with green light and greatly expanded opportunities for the uses of ignition by decoupling compression and ignition in Fast Ignition (FI)

NIF Project

Completion in 2009

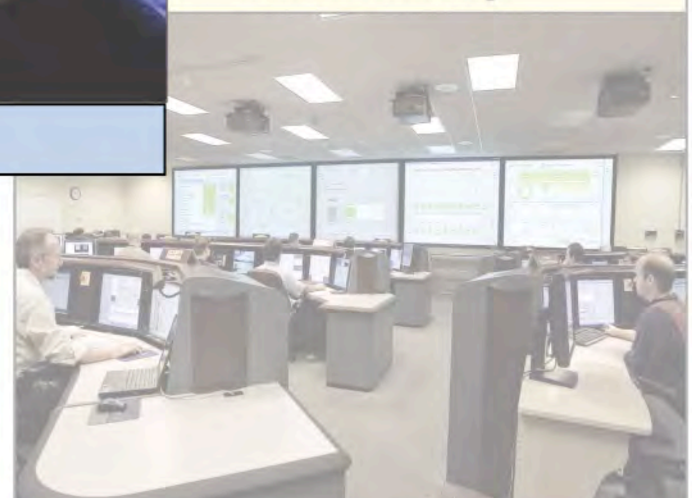
The goal of NIC is thermonuclear burn in the laboratory with a credible campaign in 2010

National Ignition Campaign



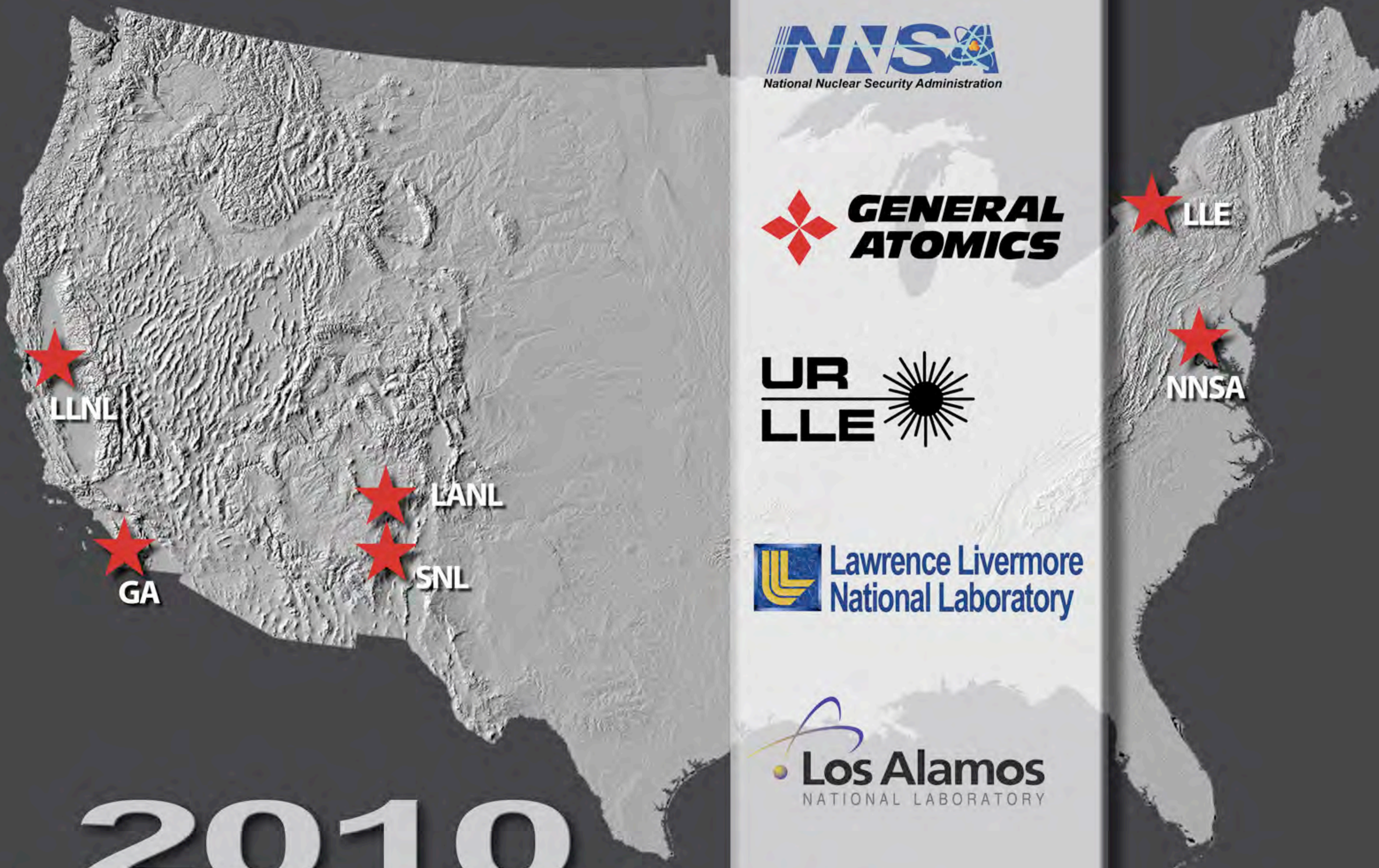
2006—2012

National User Facility



2009—2030

NIC is the bridge from NIF to routine operations of a highly flexible HED science facility



National Nuclear Security Administration

GENERAL ATOMICS

UR LLE

Lawrence Livermore National Laboratory

Los Alamos NATIONAL LABORATORY

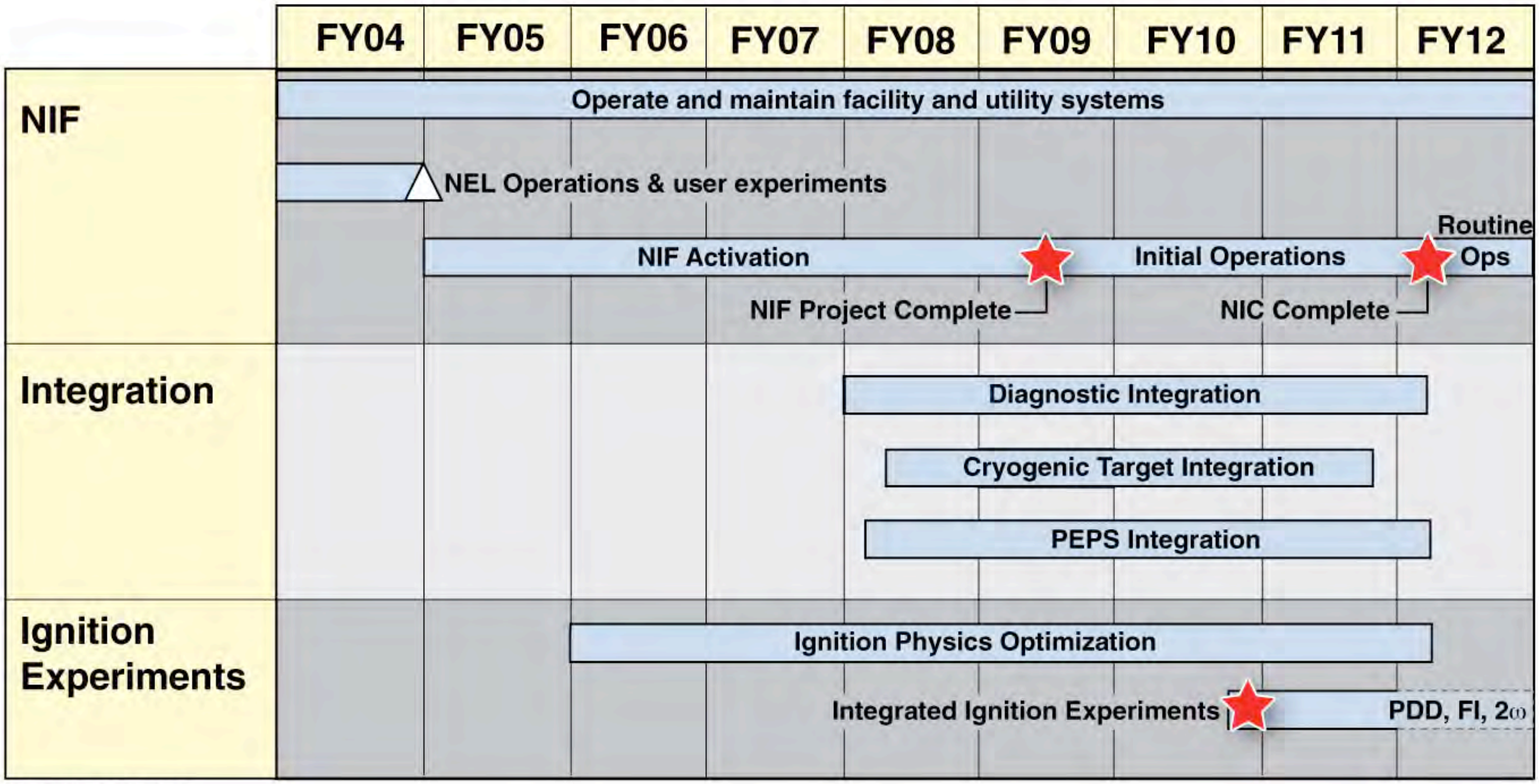
Sandia National Laboratories

2010

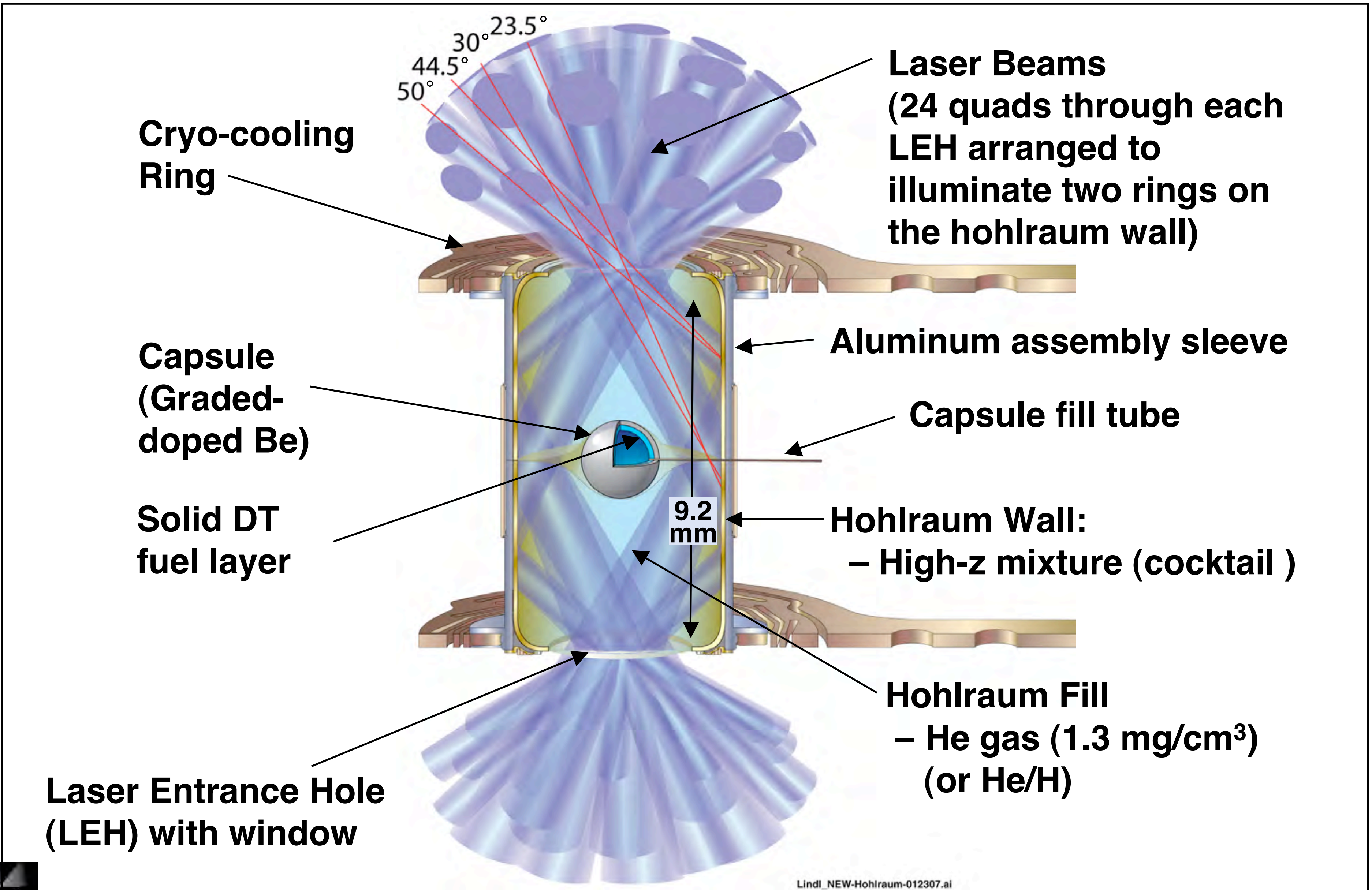
NATIONAL IGNITION CAMPAIGN

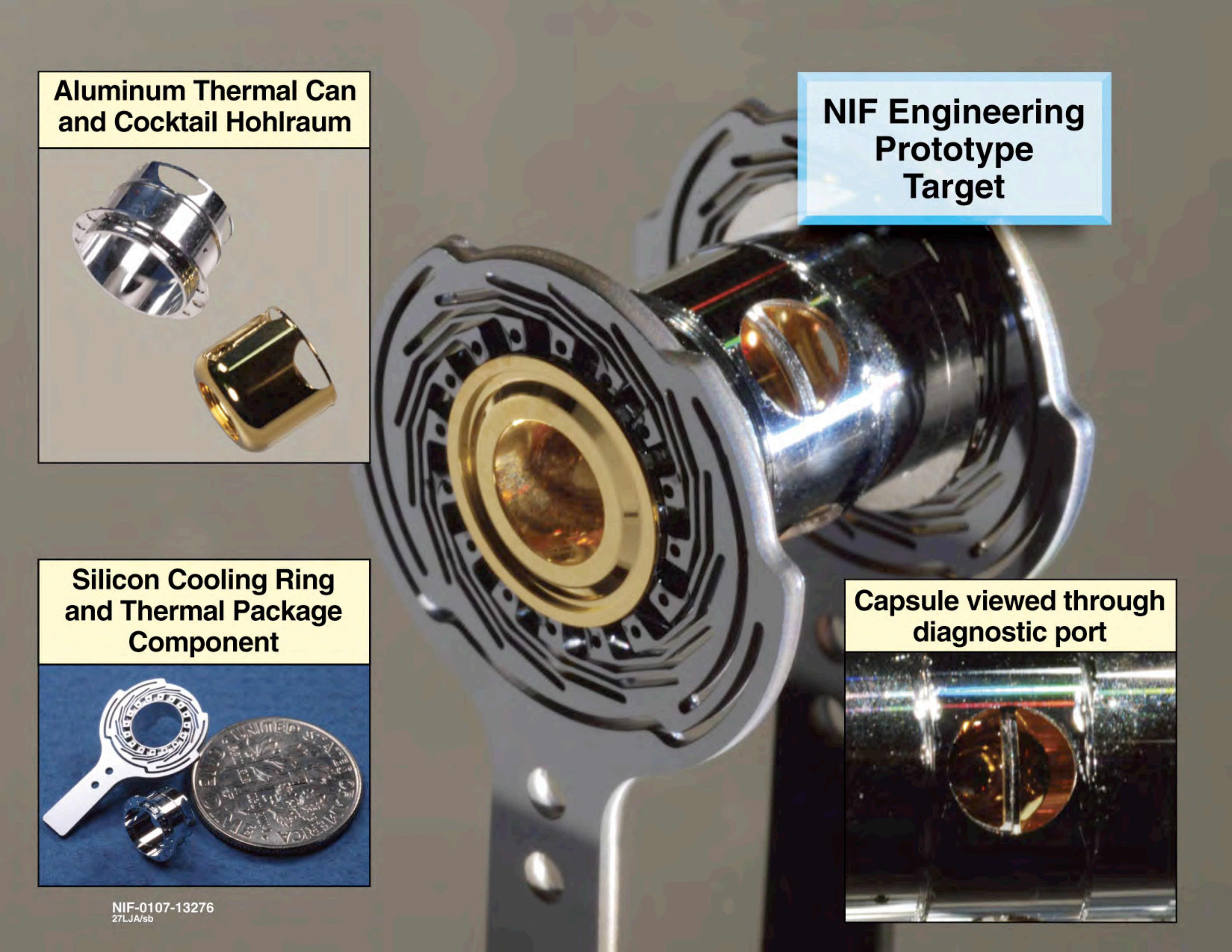
NIF/NIC Schedule

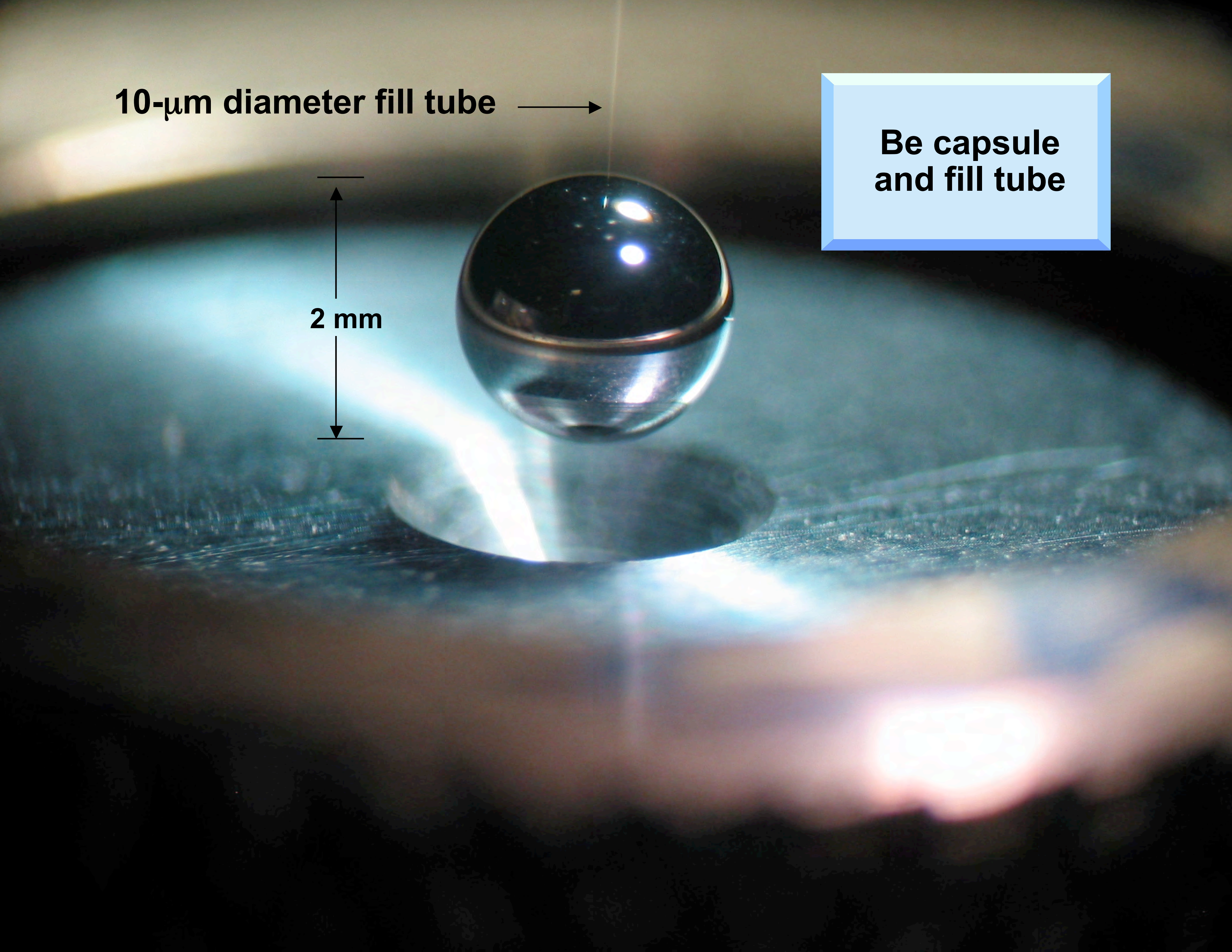
The National Ignition Campaign

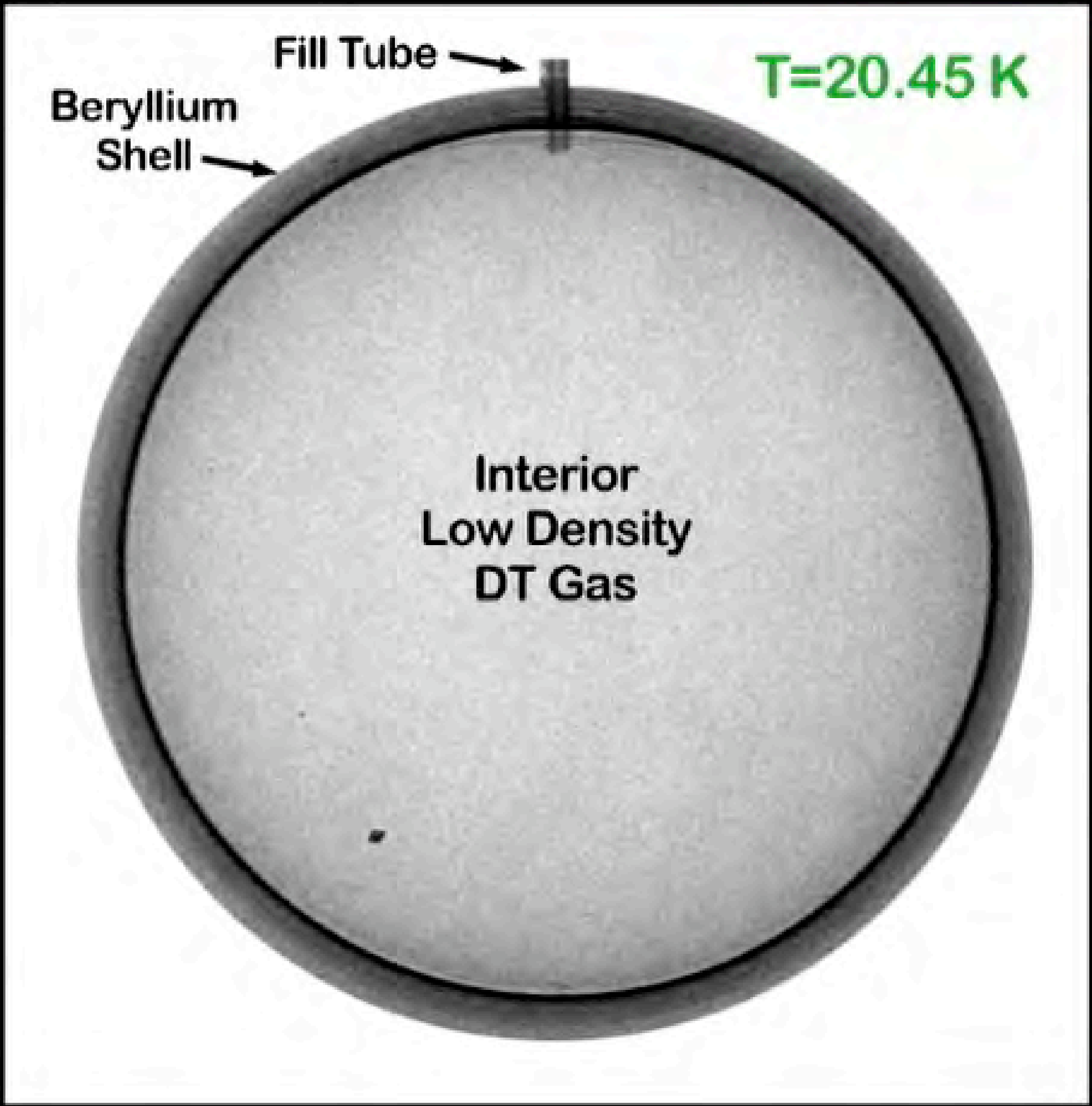


The NIF point design has a graded-doped, beryllium capsule in a $U_{0.75}Au_{.25}$ hohlraum driven at 300 eV



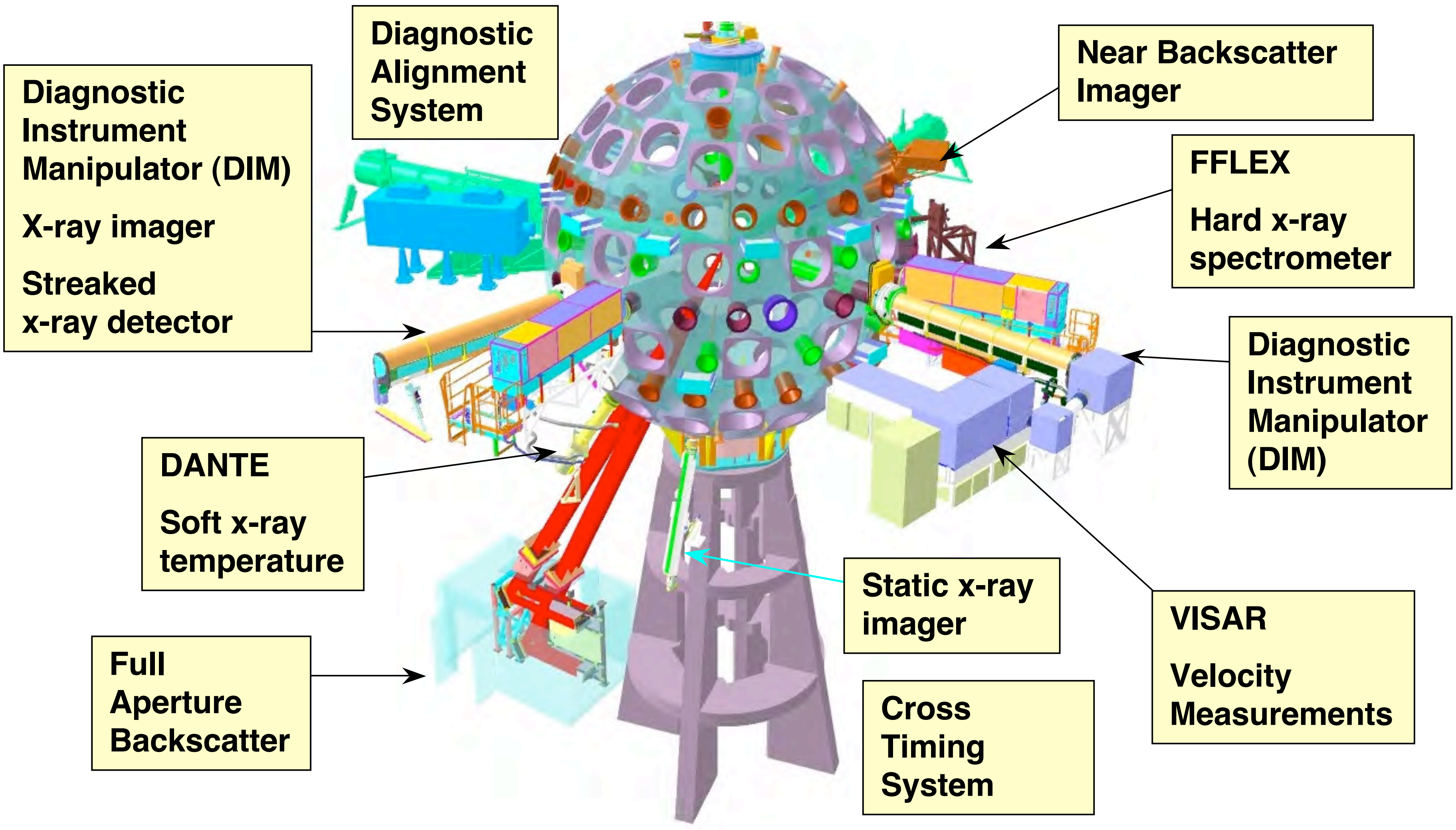

Aluminum Thermal Can and Cocktail Hohlraum
NIF Engineering Prototype Target
Silicon Cooling Ring and Thermal Package Component
Capsule viewed through diagnostic port
NIF-0107-13276
27LJA/sb


10-μm diameter fill tube
Be capsule and fill tube
2 mm

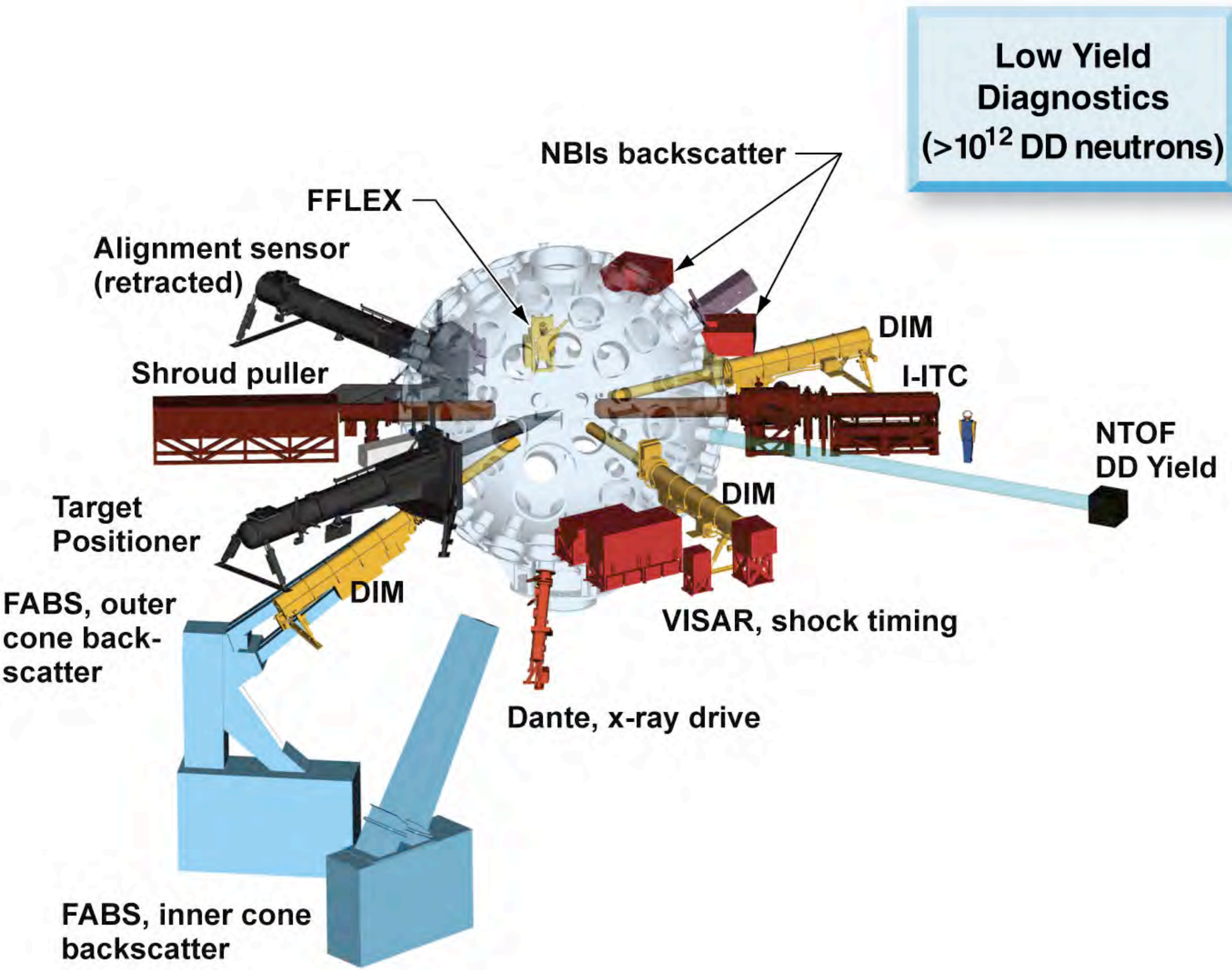


Fill Tube
T=20.45 K
Beryllium
Shell
Interior
Low Density
DT Gas

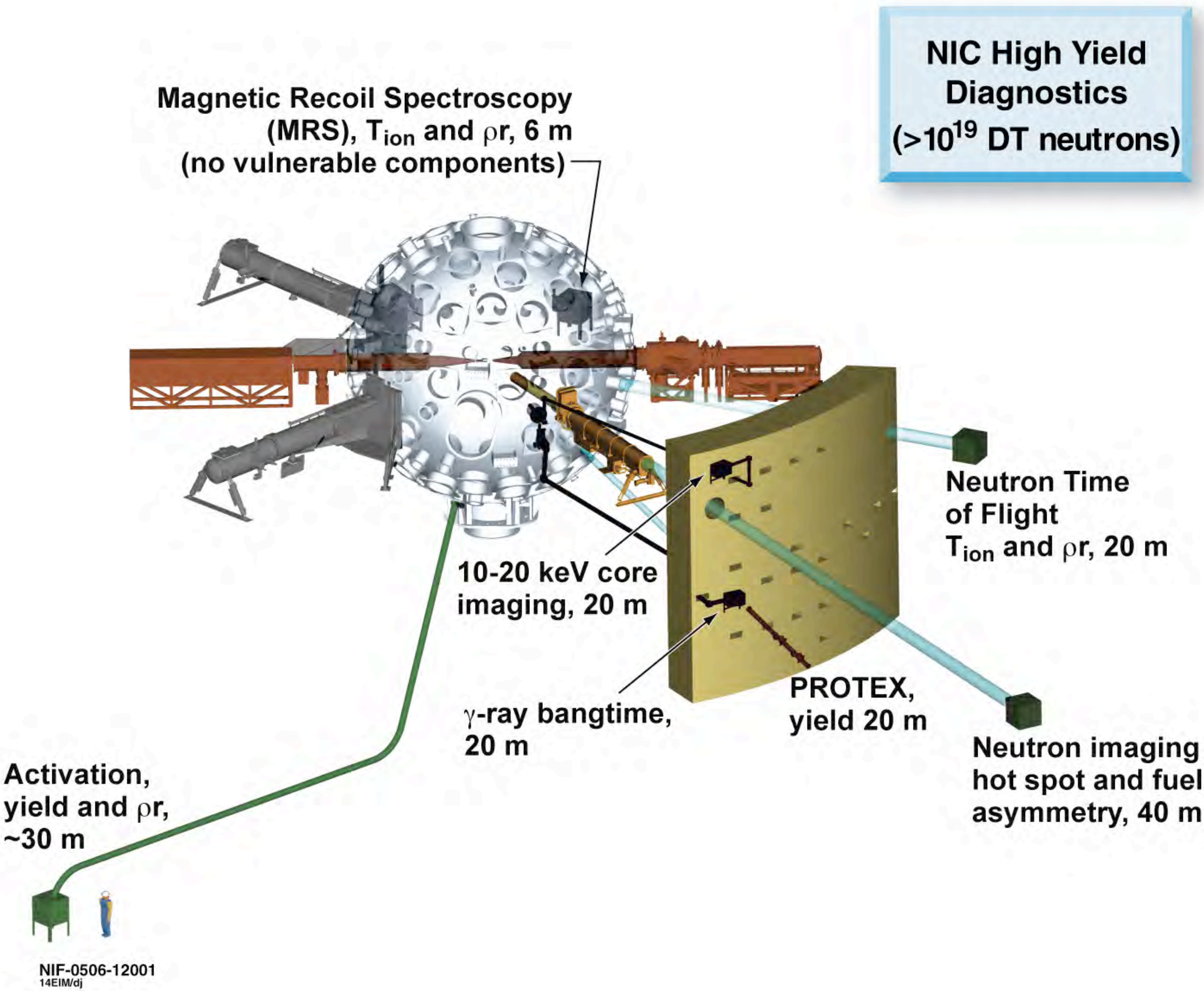
We have 30 types of diagnostic systems planned for NIC



We successfully fielded ~ half of all the types of diagnostic systems on NIF



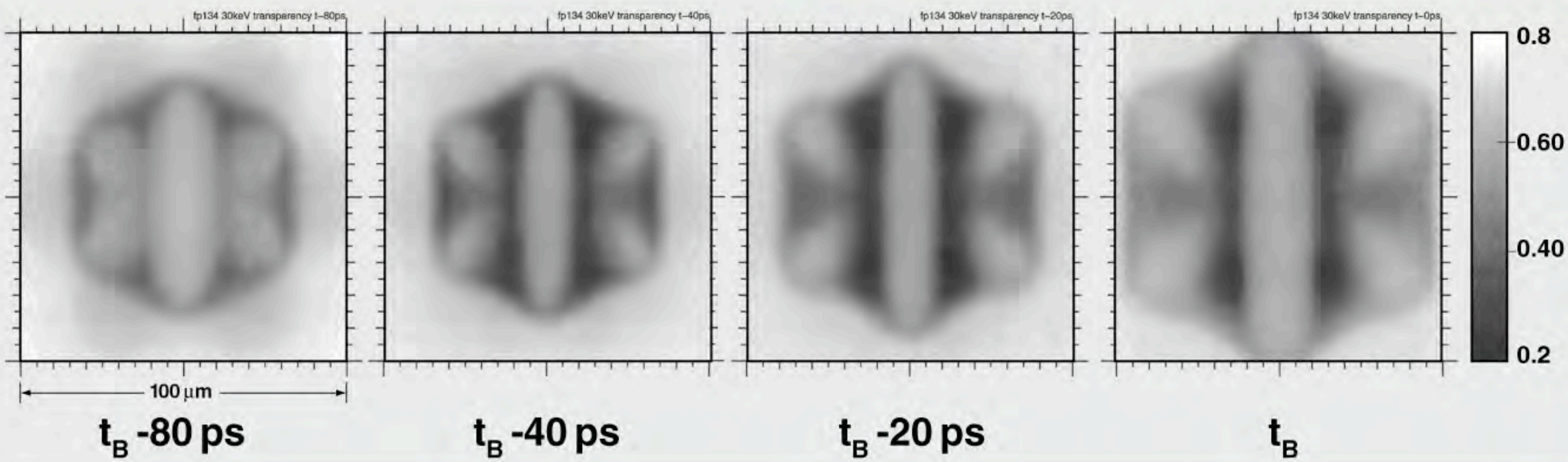
NIF-0506-12000
14EIM/dj


NIC High Yield Diagnostics ($>10^{19}$ DT neutrons)
Magnetic Recoil Spectroscopy (MRS), T_{ion} and ρr, 6 m (no vulnerable components)
Neutron Time of Flight T_{ion} and ρr, 20 m
10-20 keV core imaging, 20 m
γ-ray bangtime, 20 m
PROTEX, yield 20 m
Neutron imaging hot spot and fuel asymmetry, 40 m
Activation, yield and ρr, ~30 m
NIF-0506-12001
14EIM/dj

Multiple ARC radiographs at intervals ~20 – 80 ps with ~10 ps exposure times would produce valuable time-history data (Phys. Rev. Lett. worthy)

The National Ignition Facility

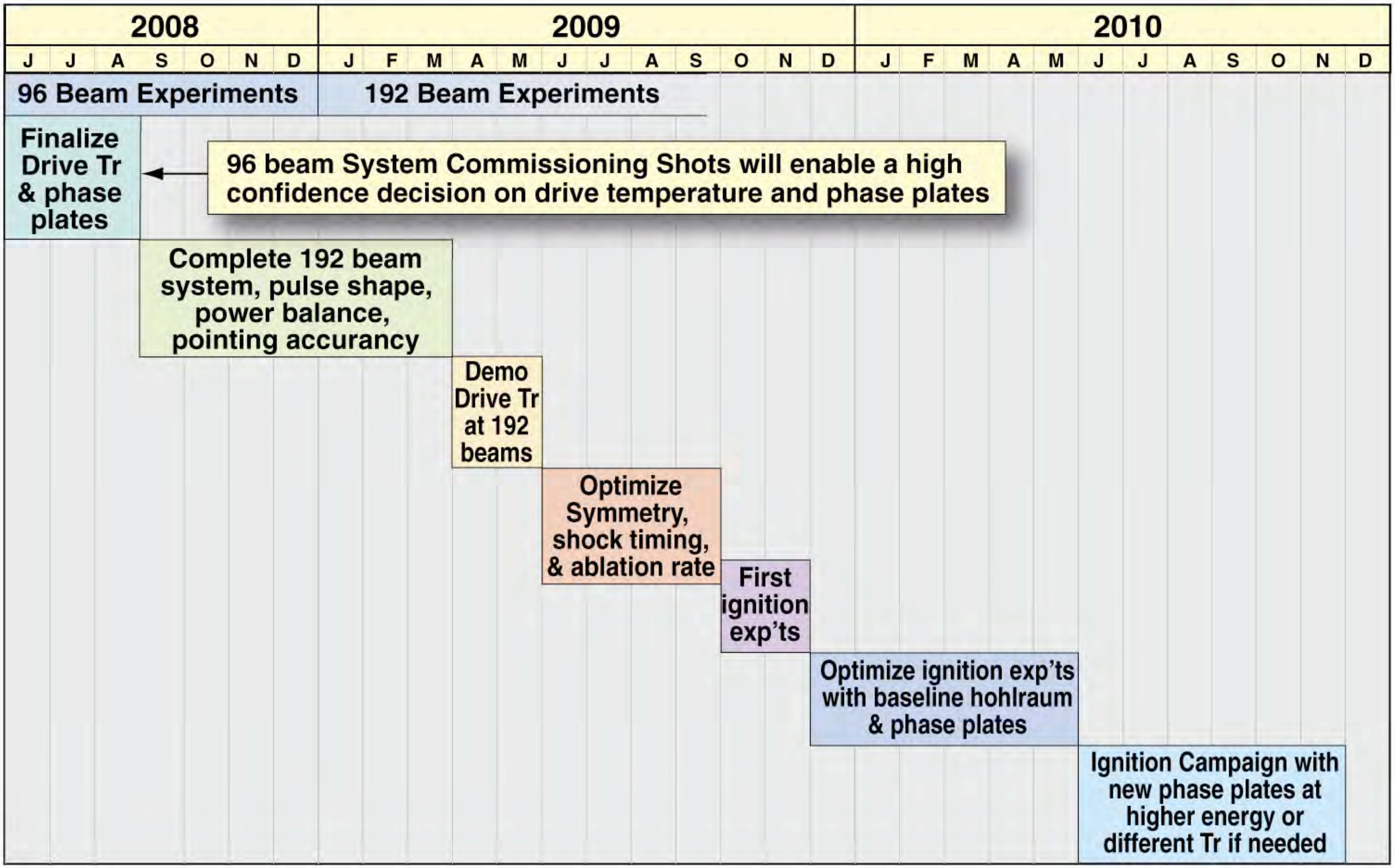
ARC Radiographs (same gray scale at all times)



Multiple ARC images combined with reaction history and primary neutron imaging provide detailed core diagnostics

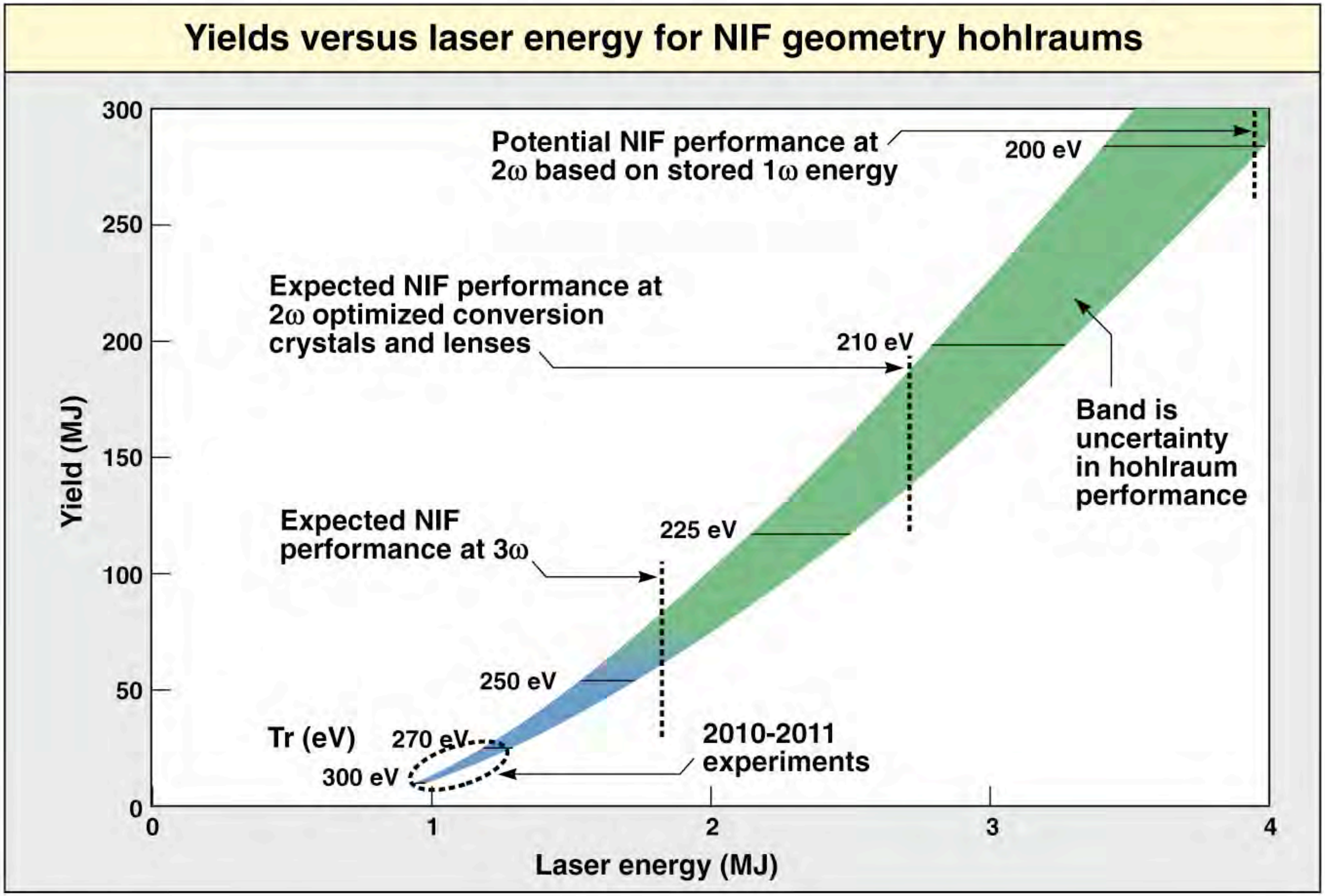
We are developing an ignition program plan during system commissioning to decrease overall risk

The National Ignition Campaign



NIF-0207-13373
16EIm/sb

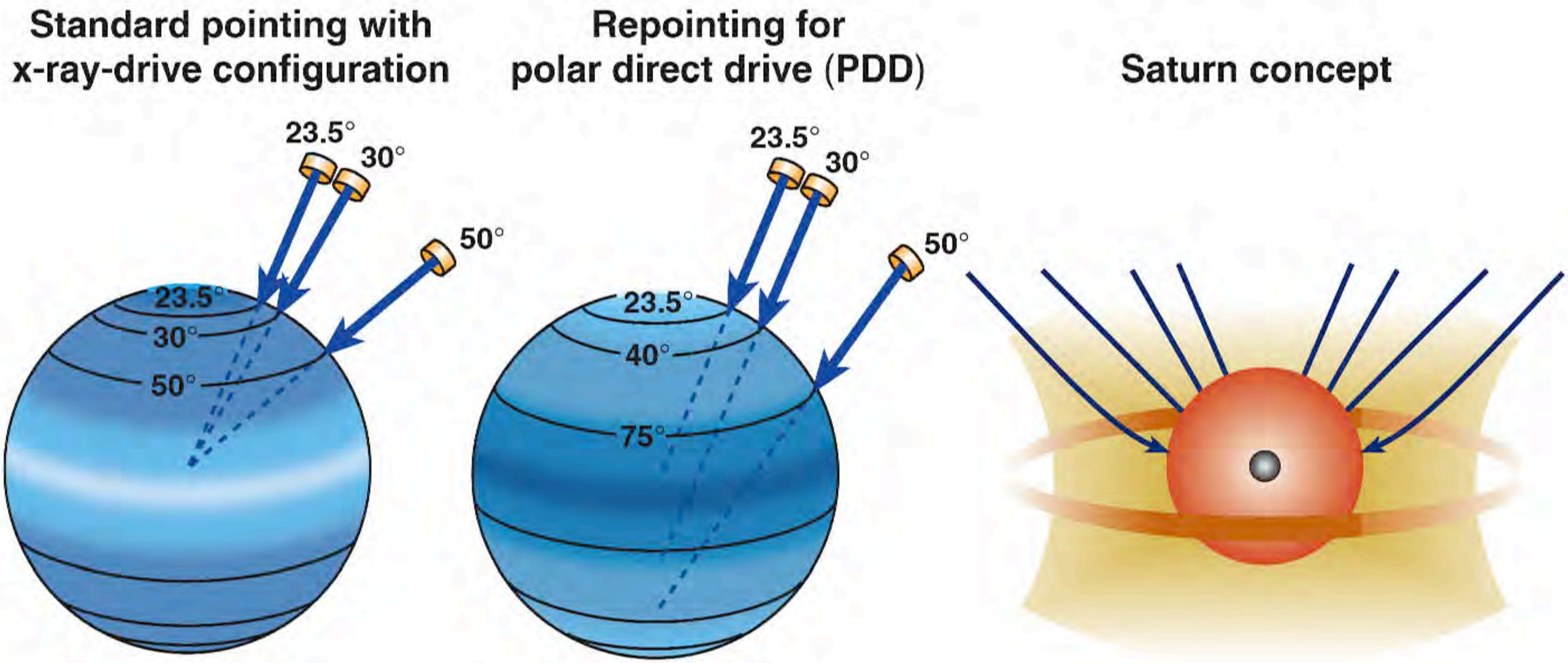
Ultimately, yields well in excess of 100 MJ may be possible on NIF



NIF-0107-13186
26JL/cld

Direct drive can achieve ignition conditions while NIF is in the x-ray-drive configuration

UR LLE



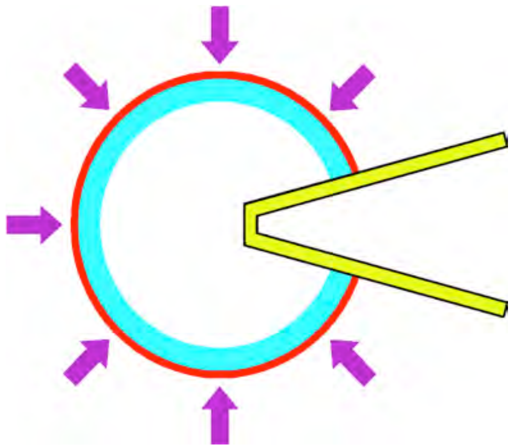
Experimental and theoretical progress gives increasing confidence in achieving PDD ignition.

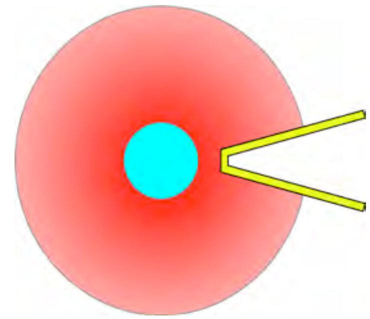
TC6300d

F. J. Marshall FO26.2, S. Skupsky poster

Fast ignition, which separates the fuel compression and ignition, will be tested on NIF

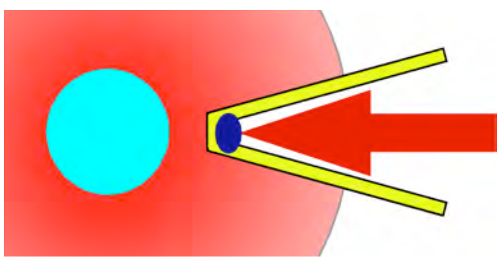
- **The compression laser assembles the fuel to uniform, high density:**



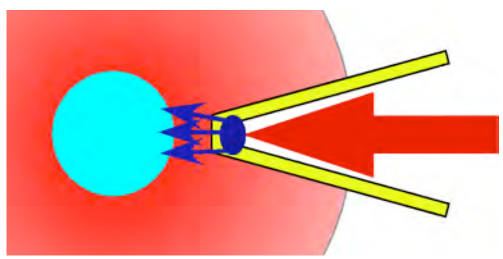


- **The ignition laser generates hot electrons that propagate through to the dense fuel and deposit their energy initiating a burn wave:**

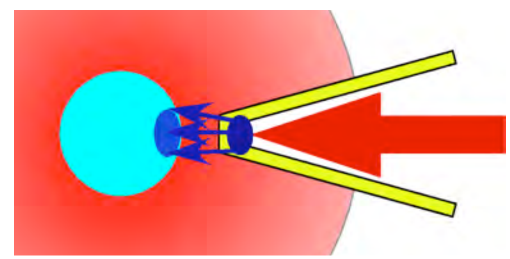
Electron generation



Electron transport

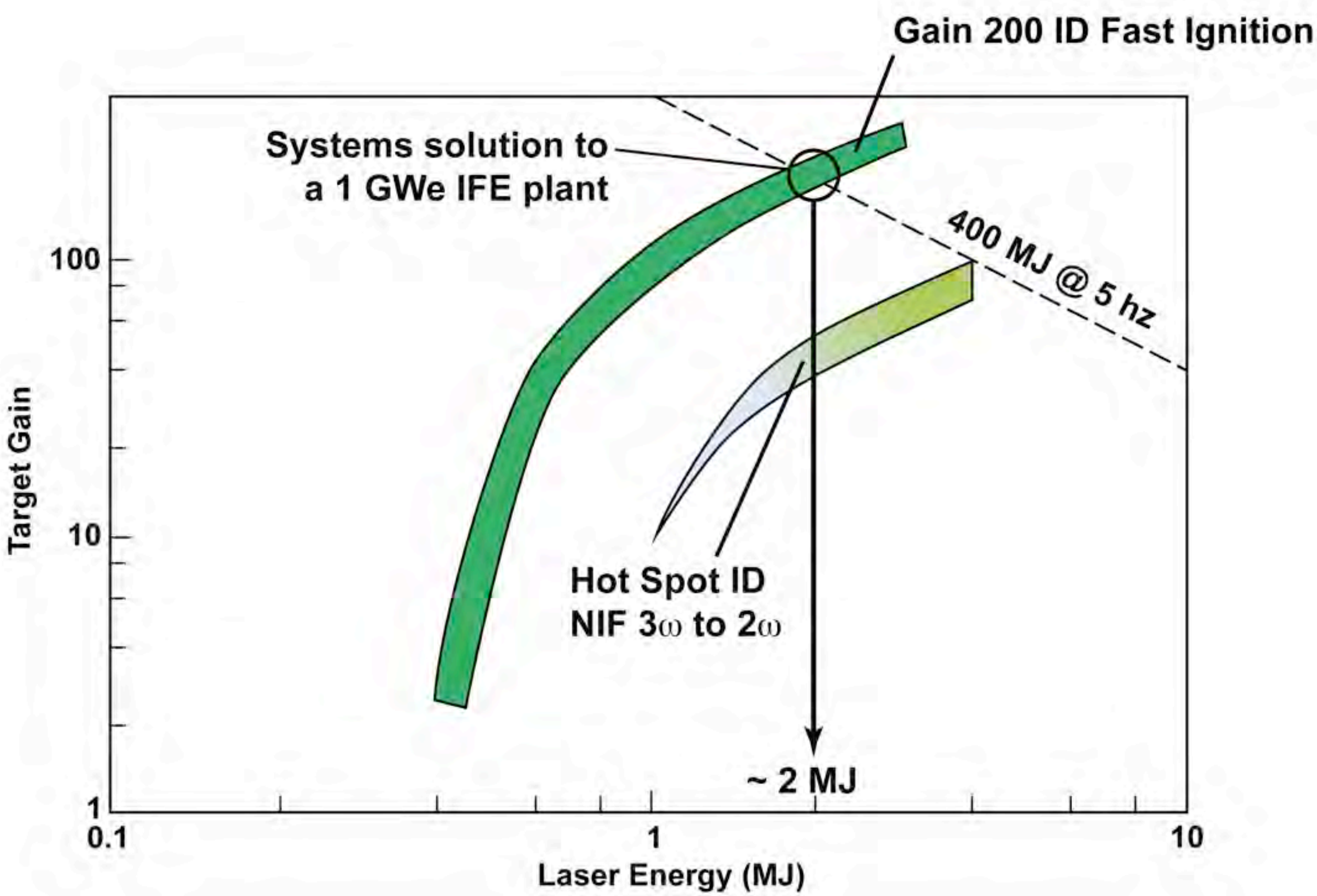


Electron deposition



When the requirements of low solid angle illumination is imposed, ID Fast Ignition stands out

The National Ignition Facility

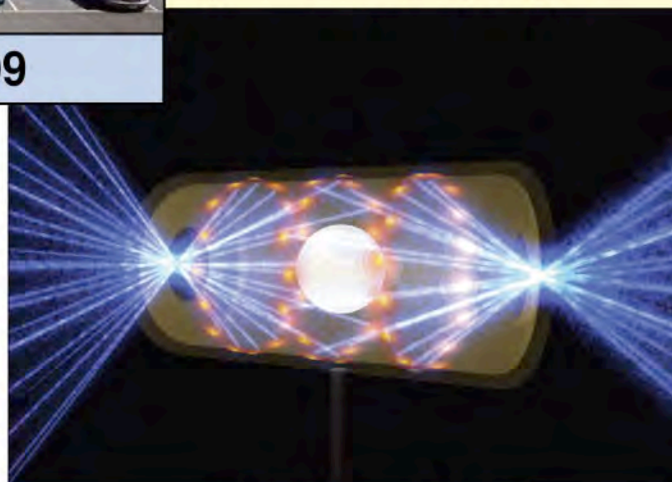


We are also studying Direct Drive FI which may offer an advantage

NIF Project

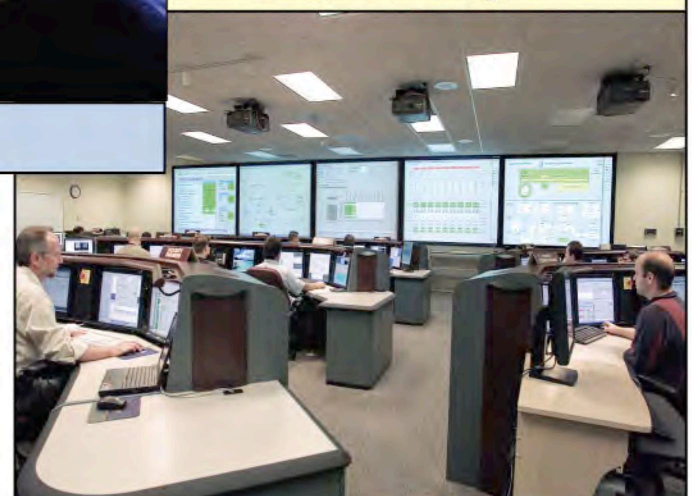
Completion in 2009

National Ignition Campaign



2006—2012

National User Facility



2009—2030

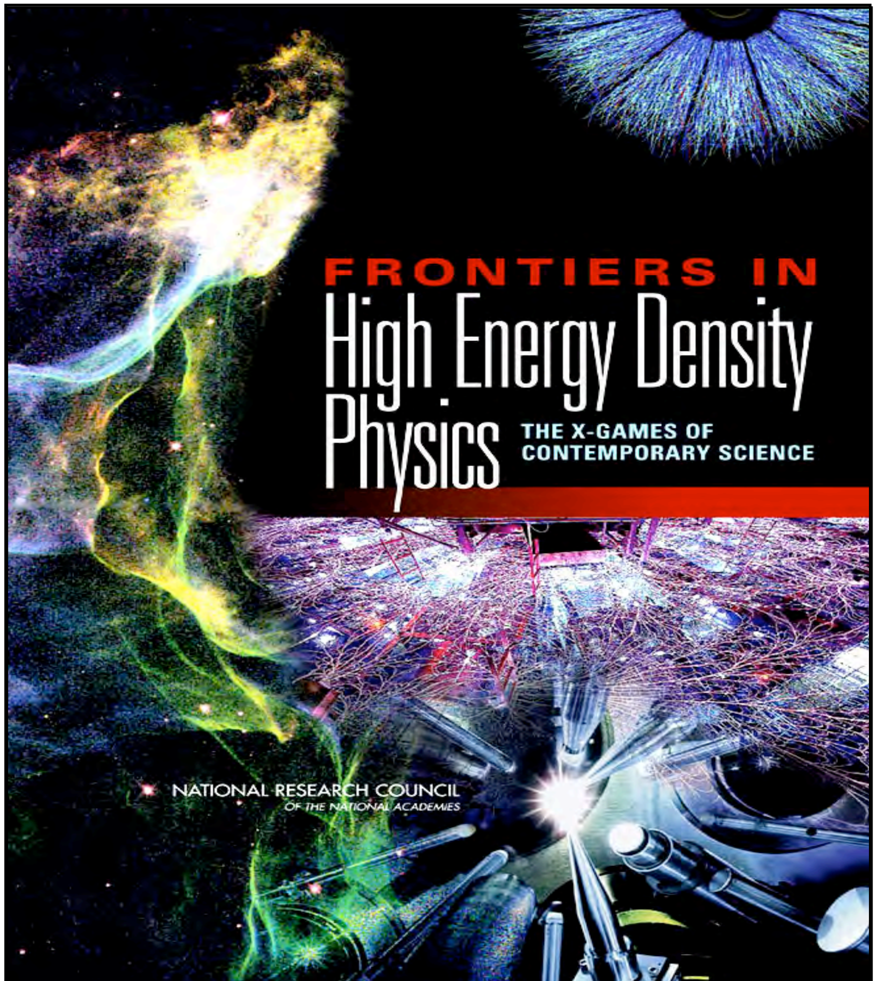
NIF is a National User Facility

- A "Governance Model" is under development
- User friendly environment is being designed

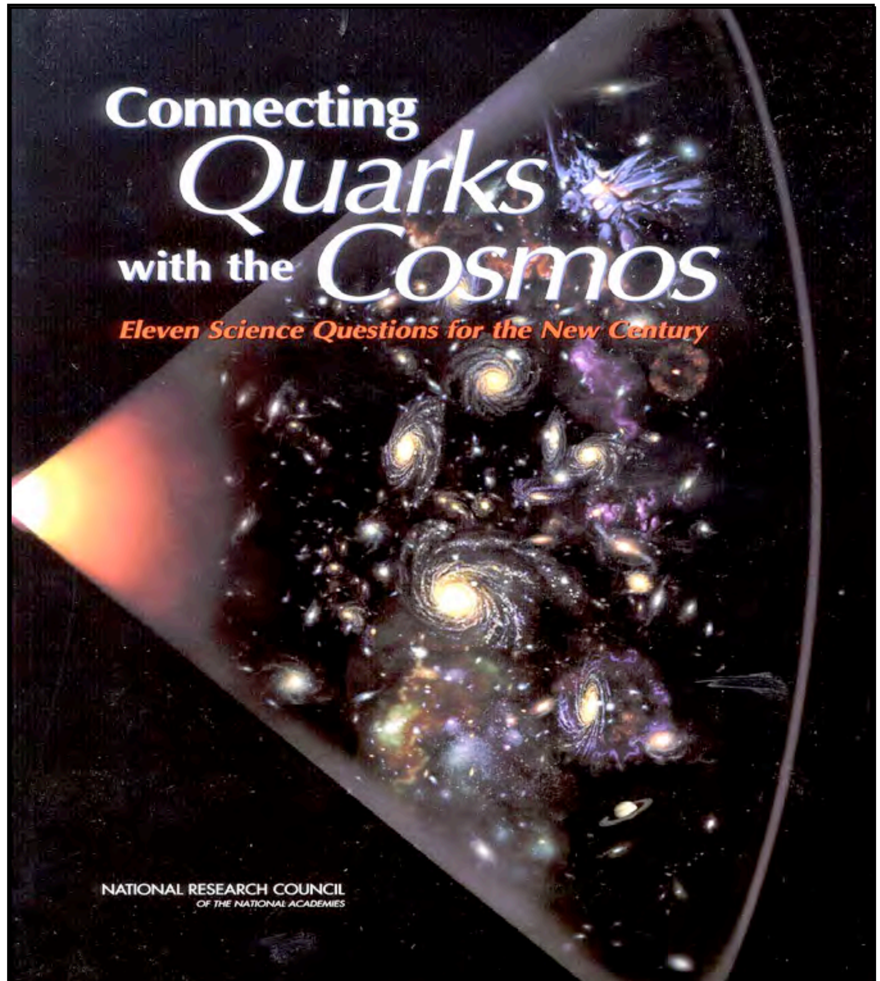
National Ignition Facility

Three Years to a New Age for Science

NIF can play a key role in international science vision



NRC committee on HEDP: X-Games of Contemporary Science

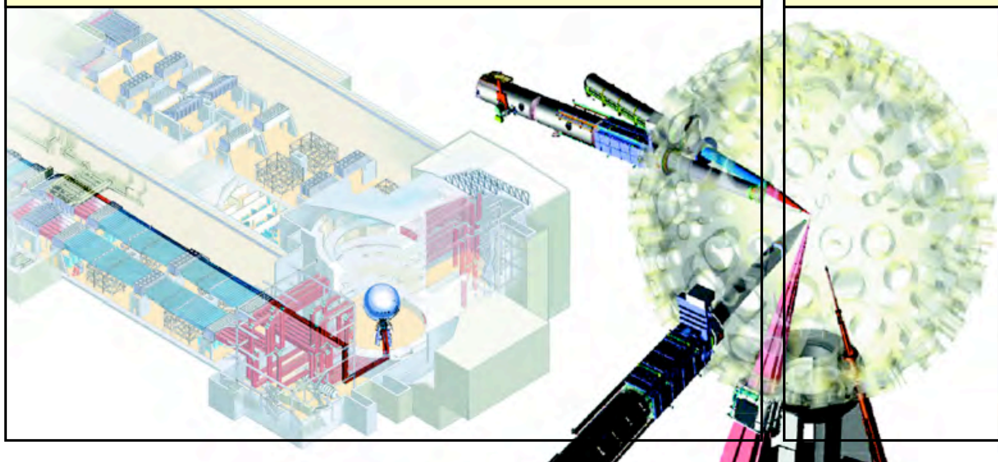


NRC committee on the Physics of the Universe

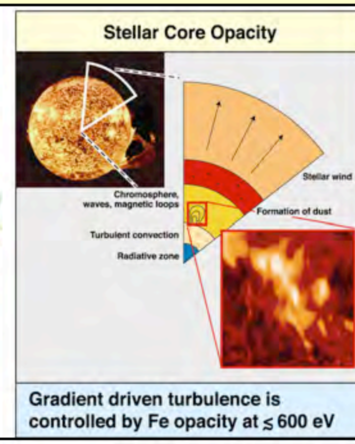
NIF will access unprecedented high energy density regimes

The National Ignition Facility

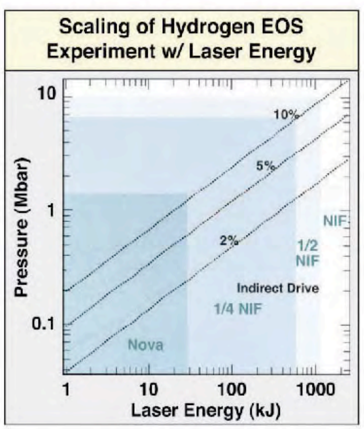
NIF Will Create a Huge Flux of Neutrons

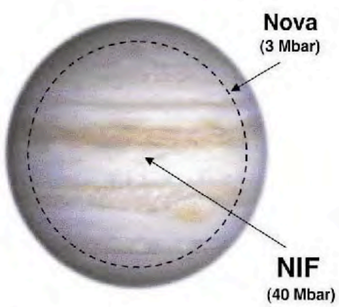


NIF Will Create Thermal Plasmas at the Conditions of Stellar Interiors

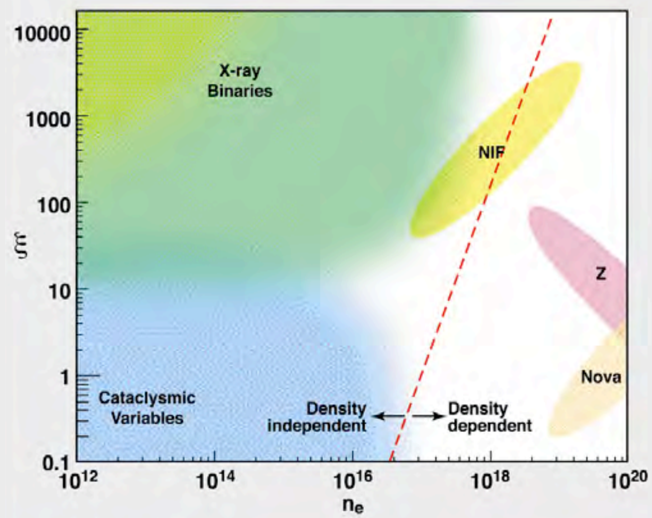


NIF Will Drive Targets to Pressures Found at the Center of Jupiter





NIF Will Produce Enough X-Ray Flux to Simulate Conditions in an Accretion Disk



NIF's Scientific Environments

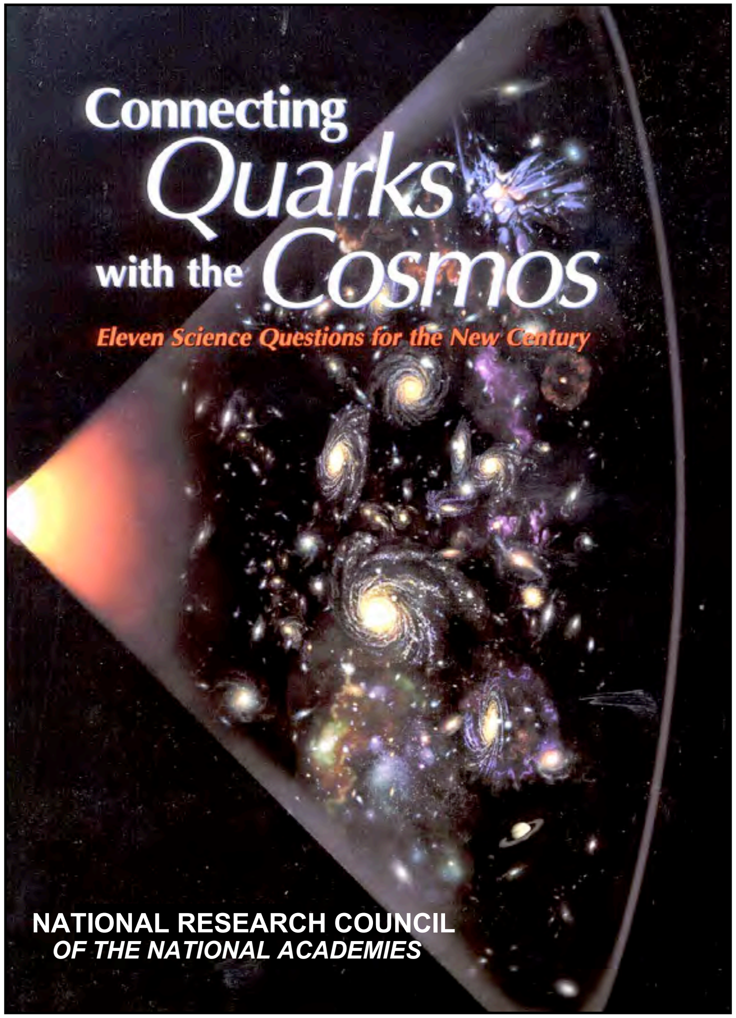
The National Ignition Facility

- These are the conditions of Extreme Laboratory Astrophysics
  - $T > 10^8$ K matter temperature
  - $\rho > 10^3$ g/cc density
  - Those are both 7x what the Sun does! Helium burning, stage 2 in stellar evolution, occurs at 2×10^8 K!

- Core-collapse Supernovae, colliding neutron stars, operate at $\sim 10^{20}$ n's/cc
  - NIF: $\rho_n = 10^{17}$ neutrons/cc
- These apply to Type Ia Supernovae!
  - Electron Degenerate conditions
  - Rayleigh-Taylor instabilities for (continued) laboratory study.
- Only need ~Mbar in shocked hydrogen to study the EOS in Jupiter & Saturn
  - Pressure $> 10^{11}$ bar

These certainly qualify as "unprecedented."

The NRC committee on the Physics of the Universe highlighted the new frontier of HED science



Eleven science questions for the new century:

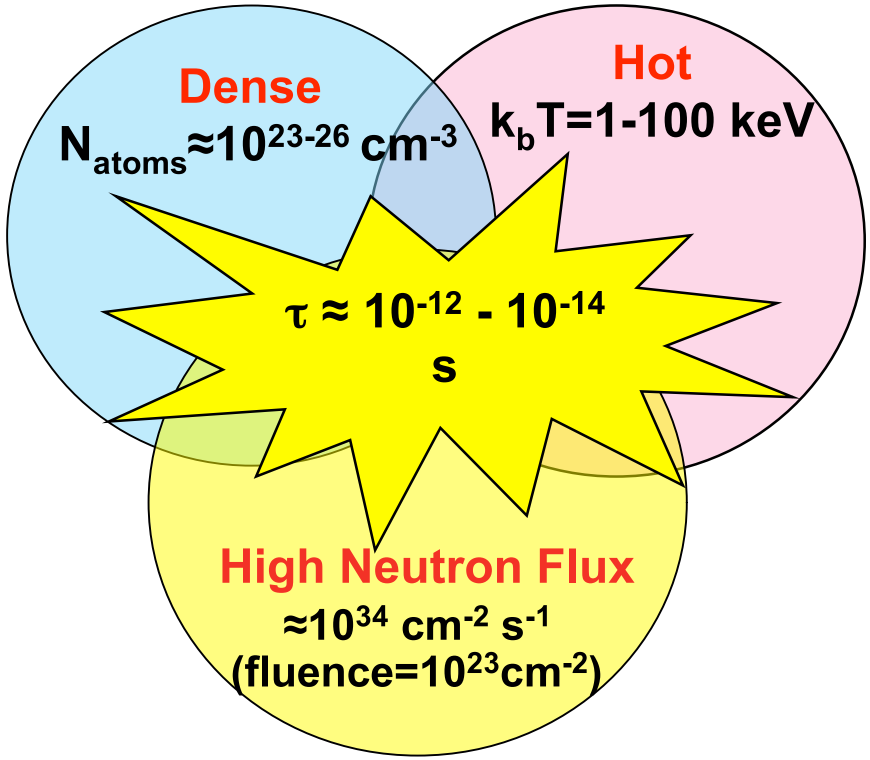
2. **What is the nature of dark energy?**
4. **Did Einstein have the last word on gravity?**
6. **How do cosmic accelerators work and what are they accelerating?**
8. **What are the new states of matter at exceedingly high density and temperature?**
10. **How were the elements from iron to uranium made?**

Findings:

- **HEDP provides crucial msmts relevant to interpreting astrophysical observations**
- **The field has great promise; should be better coordinated across the Federal agencies**

Nuclear science on NIF

- Unique conditions on NIF will enable studying:
  - Dynamics of nuclei in excited states
  - Charged particle reactions relevant to nucleosynthesis
  - Solar neutrino physics



A working group has been formed including: LLNL (Schneider), LBNL (Phair), UCB (Moretto), Univ. Notre Dame (Wischer), Colorado School of Mines (Greife), GSI, University of Oslo

NIF's planning supports DOE's goals for "civilian research" and NNSA-SC partnering

Science Sept 29 Issue, p1874

NEWSFOCUS

Ray Orbach Asks Science to Serve Society

For a decade, chemist Radoslav Adzic has explored the basic structure of metal-electrolyte interfaces at Brookhaven National Laboratory in Upton, New York. His employer, the U.S. Department of Energy (DOE), has long sponsored fundamental science on catalysis in such systems in hopes of making hydrogen fuel cells efficient enough to one day replace fossil fuels as an energy source. But it wasn't until 2004 that Adzic decided to tackle a research question with more direct applications: how to use monolayers of platinum to build cheaper fuel cells, focusing on hydrogen.

It wasn't a random decision. The year before, President George W. Bush had proposed an 8-year, $1.2 billion hydrogen fuels program that would begin with applied engineering studies. After attending a DOE-sponsored workshop to discuss the basic research needed to turn hydrogen into a commercially viable fuel, Adzic won a $700,000 grant to study …

Keys to the kingdom. No one doubts that fundamental research could better fulfill energy needs. A 1997 report by the President's Council of Advisors on Science and Technology, for example, called for "better coordination" between basic and applied energy research. "Everyone knows it's a problem, but nothing's happened," says physicist George Crabtree, a manager at DOE's Argonne National Laboratory in Illinois.

One obstacle is the current rewards system in academia. Take the science behind superconductivity, which holds the promise of low-resistance power lines or incredibly efficient transformers. The kind of discovery that earns a scientist a paper in a top journal—learning why a material changes phase at a certain temperature—is too theoretical to help a company trying to make superconducting materials. But a commercially valuable yet incremental improvement in that technology wouldn't interest those top-tier journals. So a scientist might not even bother to record such an advance. "If the currency is just *PRL* [*Physics Review Letters*], *Nature*, and *Science*, you'll just move on," says materials scientist John Sarrao of Los Alamos National Laboratory in New Mexico.

Another barrier to developing new technologies, says Bodman, is DOE's current compartmentalized bureaucracy. In July, he sent out a memo giving Orbach "detailed access" to DOE's vast empire, hoping that regular meetings among disparate programs will break through that mentality. It's not a new concept, Orbach says, but "what's new is the intensity and importance" of those meetings.

Money greases the wheels of cooperation. In addition to the hydrogen initiative and a similar effort in solar energy, Orbach has called for $250 million for biofuel start-ups involving industrial scientists, technologists, and genomicists (*Science*, 11 August, p. 746). Sharlene Weatherwax, a DOE program manager, says a previous partnership with DOE's technology program might have consisted of a single grant.

Orbach knows that change doesn't come easily for areas, such as nuclear weapons development, that have traditionally been walled off from civilian research. In initial meetings with applied-research managers, he admits, "people don't quite know what to make of us." But Edward Moses, director of the National Ignition Facility, a superlaser at Lawrence Livermore National Laboratory in California, says Orbach is helping him grow a civilian research community to utilize an instrument designed to maintain the nation's nuclear arsenal.

Some fear that such cross-fertilizing could weaken basic science at DOE. "There is a danger of letting the basic program become a technical-

Teammates. Ray Orbach (*left*) hopes researchers can help his boss, Energy Secretary Samuel Bodman, (*right*) do his job, too.

support enterprise for the applied programs," says energy expert Robert Fri, a former Environmental Protection Agency official who believes unfettered basic work can "cook up" whole new energy ideas. Materials scientist Ward Plummer of the University of Tennessee, Knoxville, decries a 20% decline in funding core, unsolicited research within DOE's Office of Basic Energy Sciences in the last 3 years at the same time that solar energy, nanotechnology, and hydrogen programs have grown.

Plummer and others hope that DOE's new effort to define so-called grand challenges will stop that erosion. And although Orbach says he has no plans to "fuzz the boundaries" between basic and applied work, he is looking for greater cooperation between the two camps. A recent discussion with managers studying how fluids flow in dry soil at DOE's planned nuclear waste fuel repository at Yucca Mountain, Nevada, proves its value, he says. "When we met with Fossil Energy and learned more about carbon dioxide sequestration," Orbach recalls, "it suddenly popped out that that's the same problem."

Whatever happens, Orbach says DOE is determined to squeeze more impact out of its science. That's good news for Adzic, who relishes taking on challenges "directly important to society." It's also a good deal for academics. "If you publish something relevant" to a problem, says Adzic, "your paper is more [often] cited."

–ELI KINTISCH

1874 29 SEPTEMBER 2006 VOL 313 SCIENCE www.sciencemag.org

Published by AAAS

Orbach knows that change doesn't come easily for areas, such as nuclear weapons development, that have traditionally been walled off from civilian research. In initial meetings with applied-research managers, he admits, "people don't quite know what to make of us." But Edward Moses, director of the National Ignition Facility, a superlaser at Lawrence Livermore National Laboratory in California, says Orbach is helping him grow a civilian research community to utilize an instrument designed to maintain the nation's nuclear arsenal.

“External Users” participated in the 2004 NIF Early Light Experiments

Physical Review Letters

PRL 94, 095005 (2005) — week ending 11 MARCH 2005

Experimental Investigation of High-Mach-Number 3D Hydrodynamic Jets at the National Ignition Facility

B. E. Blue,[1] S. V. Weber,[1] S. G. Glendinning,[1] N. E. Lanier,[2] D. T. Woods,[1] M. J. Bono,[1] S. N. Dixit,[1] C. A. Haynam, J. P. Holder,[1] D. H. Kalantar,[1] B. J. MacGowan,[1] A. J. Nikitin,[1] V. V. Rekow,[1] B. M. Van Wonterghem,[1] E. I. Moses, P. E. Stry,[1] B. H. Wilde,[2] W. W. Hsing,[2] and H. F. Robey[1]

[1]Lawrence Livermore National Laboratory, Livermore, California 94550, USA
[2]Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA

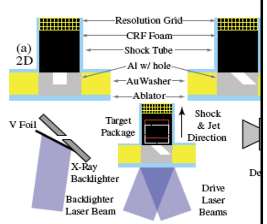


FIG. 1 (color). Schematic of a 2D target (a), a 3D target and the radiographic configuration used on NIF (c)

Los Alamos National Lab

Nuclear Fusion

Institute of Physics Publishing — Nuclear Fusion
Nucl. Fusion 44 (2004) S185–S190

Progress in long scale length laser–plasma interactions

[1] University of Rochester, Laboratory for Laser Energetics, Rochester, NY, USA

University of Rochester, LLE

Physics of Plasmas

PHYSICS OF PLASMAS 13, 032703 (2006)

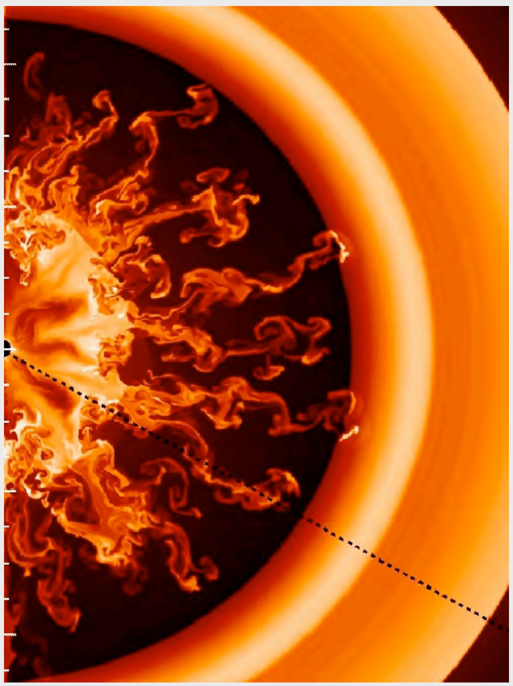
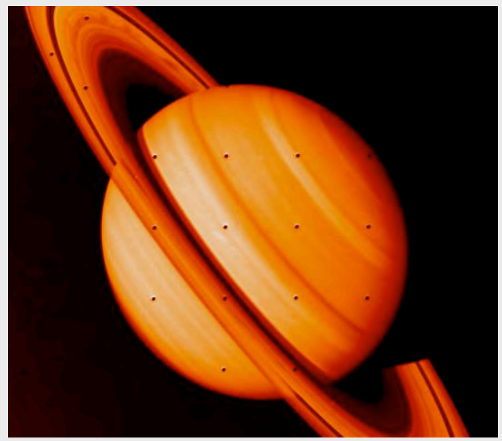
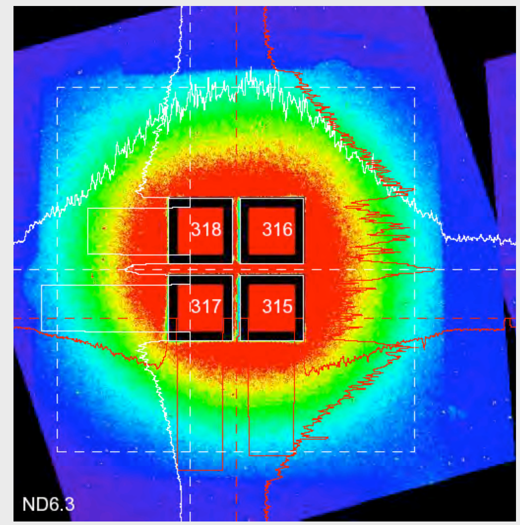
Hard x-ray and hot electron environment in vacuum hohlraums at the National Ignition Facility

[a]Atomic Weapons Establishment, Aldermaston, United Kingdom.

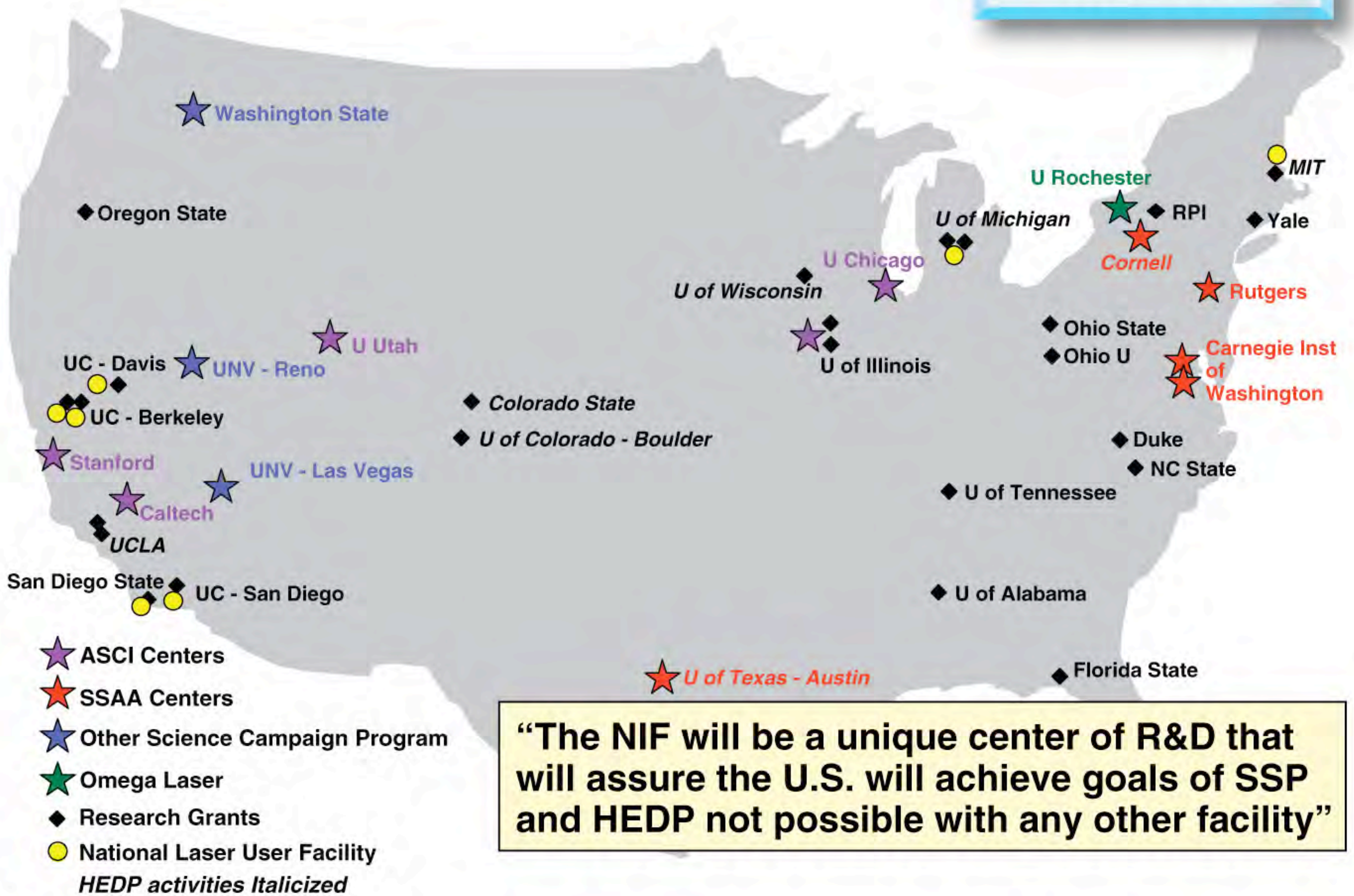
Atomic Weapons Establishment

Three university teams are starting to prepare for NIF shots in unique regimes of HED physics

The National Ignition Facility

Astrophysics - hydrodynamics	Planetary physics – EOS	Nonlinear optical physics – LPI
		
Paul Drake, PI, U. of Mich. David Arnett, U. of Arizona, Adam Frank, U. of Rochester, Tomek Plewa, U. of Chicago, Todd Ditmire, U. Texas-Austin LLNL hydrodynamics team	Raymond Jeanloz, PI, UC Berkeley Thomas Duffy, Princeton U. Russell Hemley, Carnegie Inst. Yogendra Gupta, Wash. State U. Paul Loubeyre, U. Pierre & Marie Curie, and CEA LLNL EOS team	Christoph Niemann, PI, UCLA NIF Professor Chan Joshi, UCLA Warren Mori, UCLA Bedros Afeyan, Polymath David Montgomery, LANL Andrew Schmitt, NRL LLNL LPI team

U.S. Academic Alliance

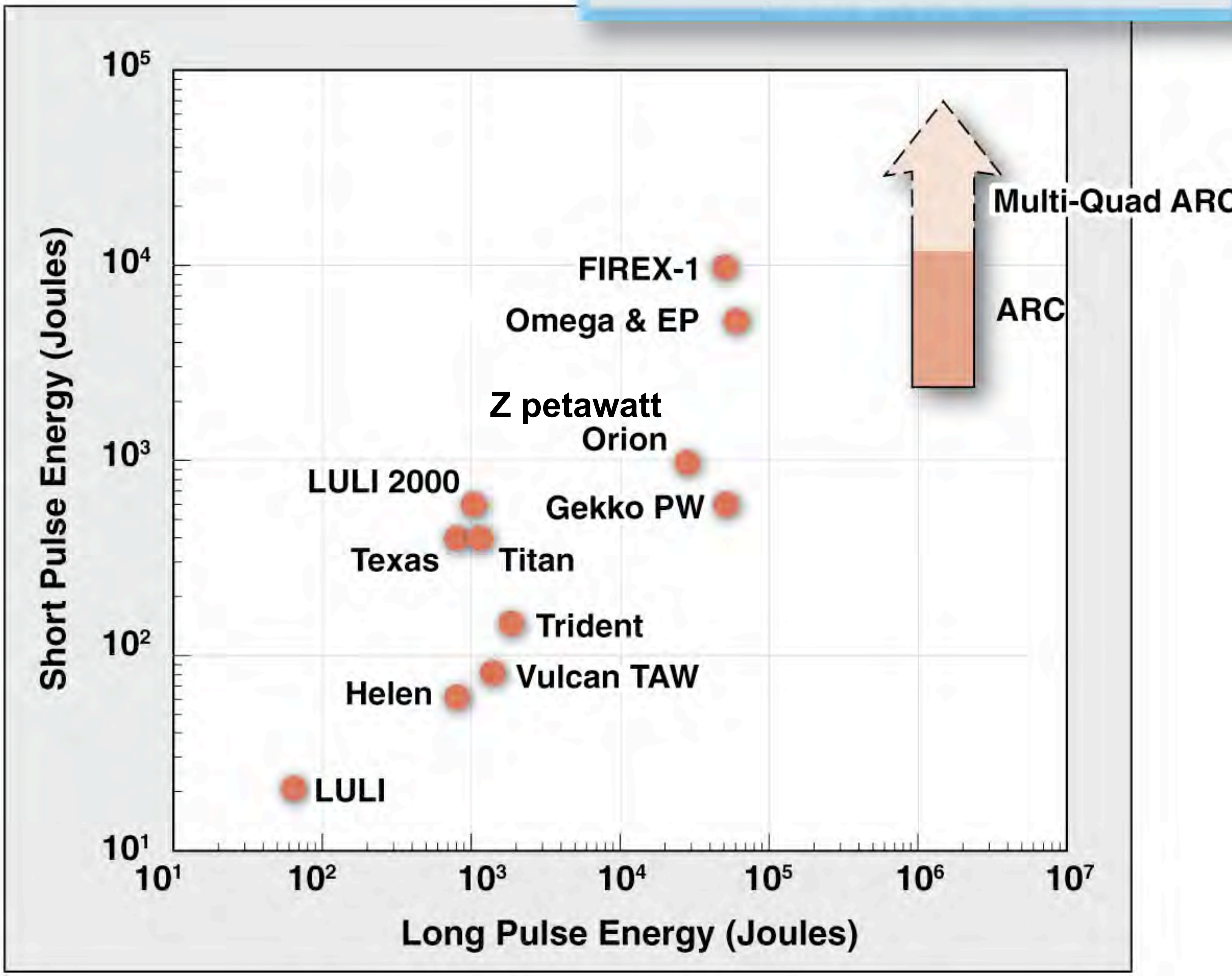


"The NIF will be a unique center of R&D that will assure the U.S. will achieve goals of SSP and HEDP not possible with any other facility"

Partnering with the International Community

NIF-1006-12815
11EIM/cld

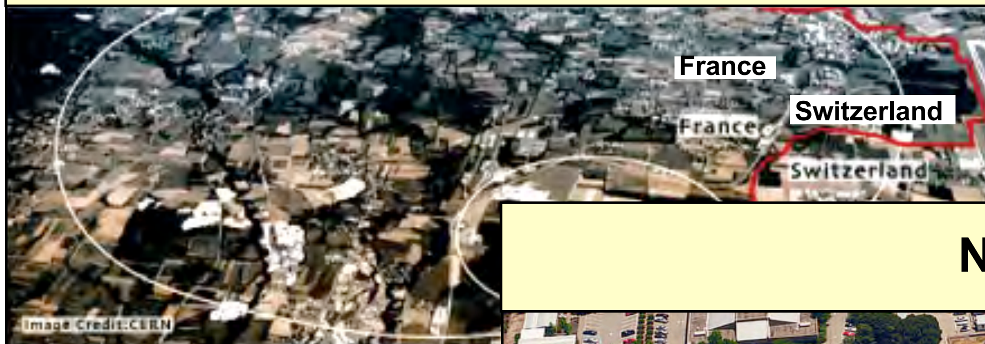
NIF will be an integral member of the HED community



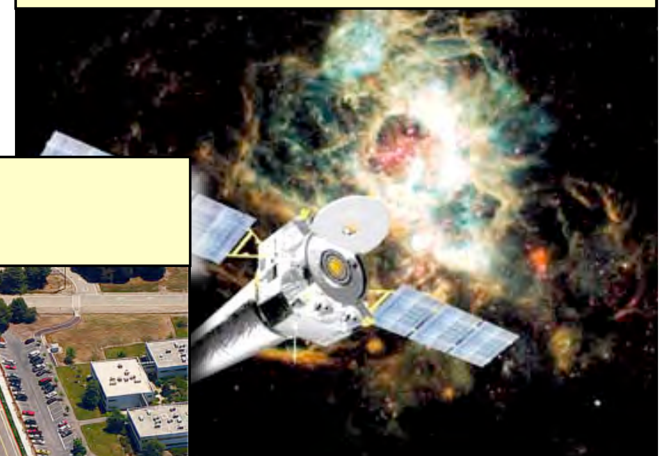
NIF-0906-12654r5
25EIM/dj

Our goal: turn NIF into the premier international center for HED experimental science

CERN



Chandra X-ray Observatory

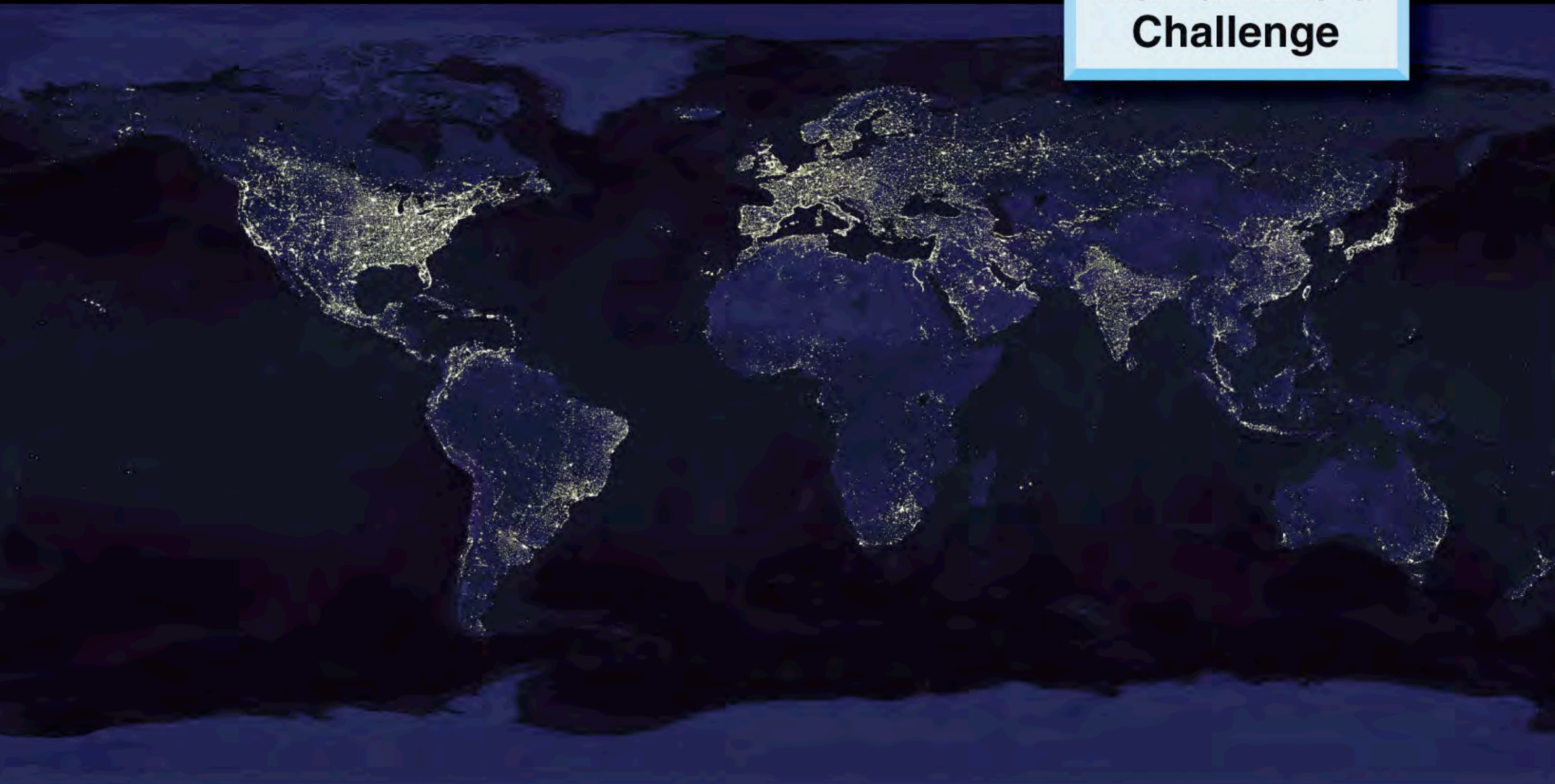


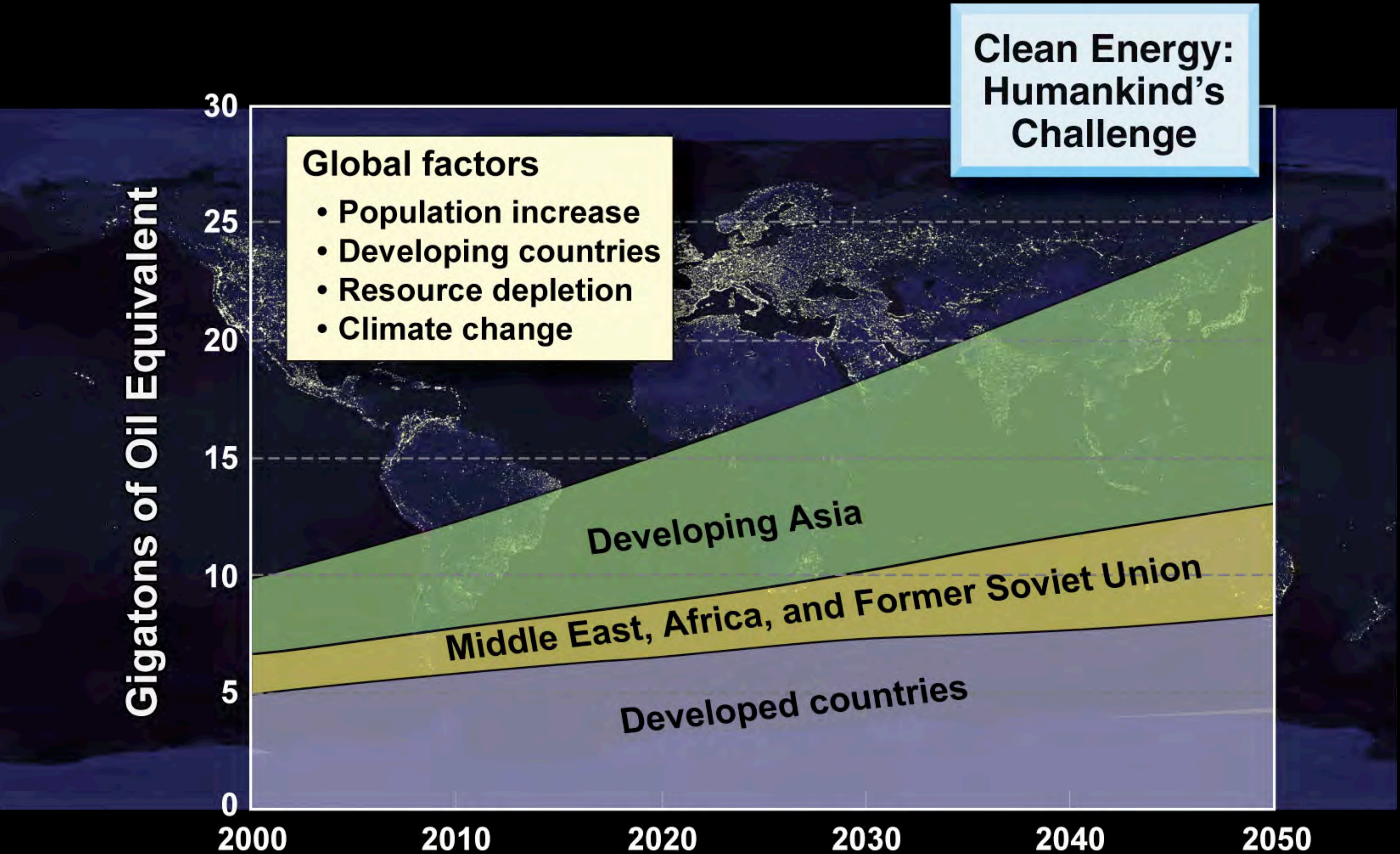
NIF

APS

SLAC

Clean Energy: Humankind's Challenge



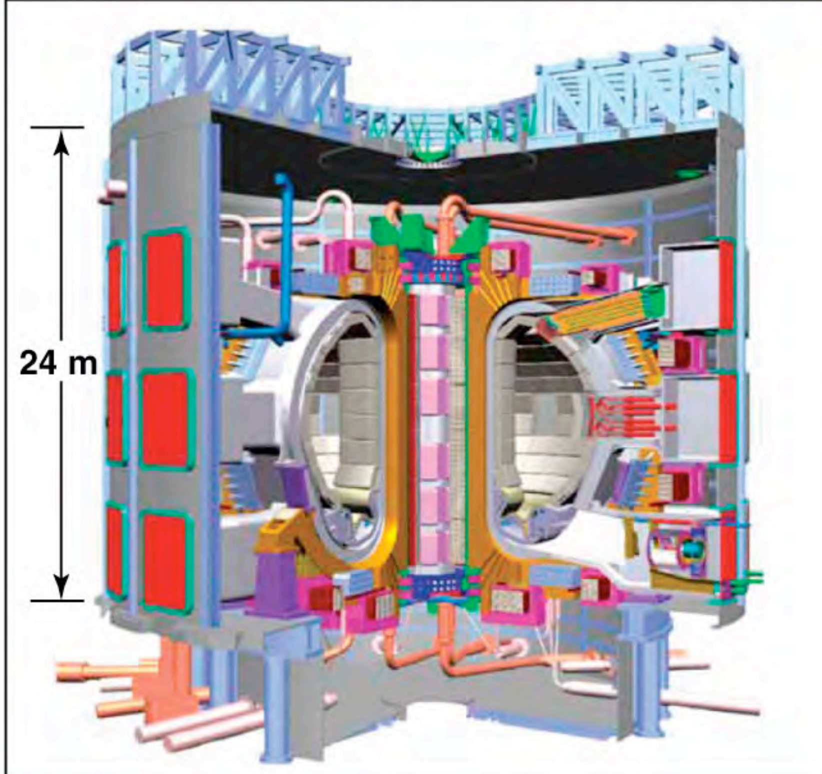
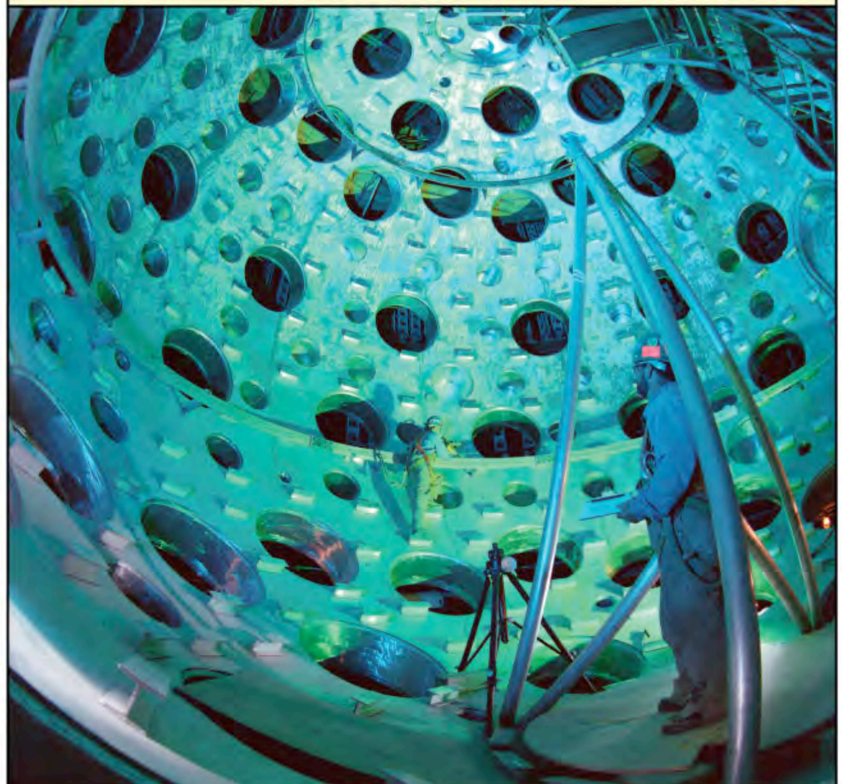


NIF-0205-10331-L1
15EIM/sb

P8478

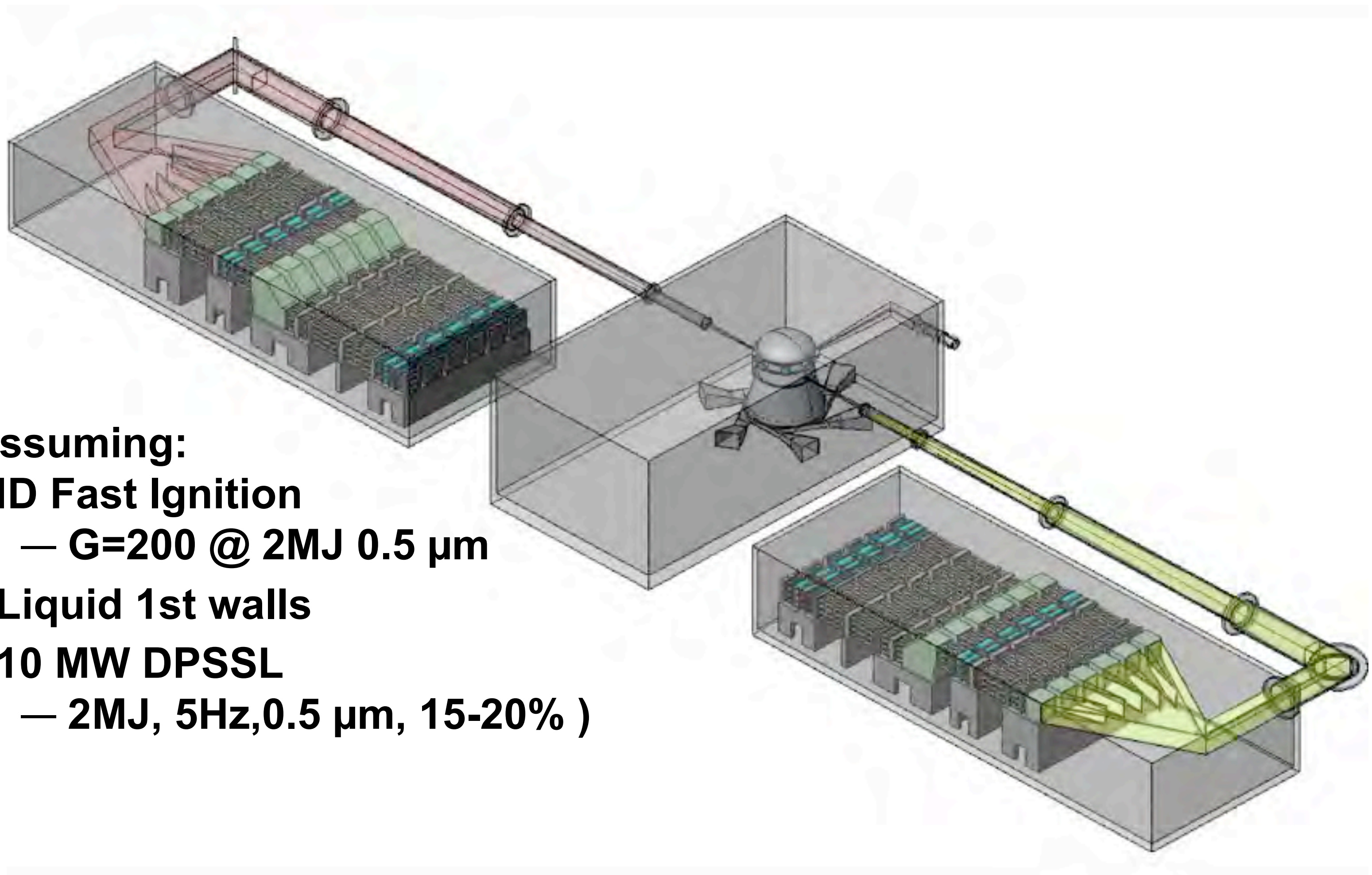
There are two major possibilities for fusion energy

The National Ignition Facility

Magnetic Fusion Energy (1951)	Inertial Fusion Energy (1960)
	
DOE Office of Science	DOE NNSA

Challenges include making it safe, reliable, and cost effective

We have performed a systems study of a 1 GWe IFE power plant

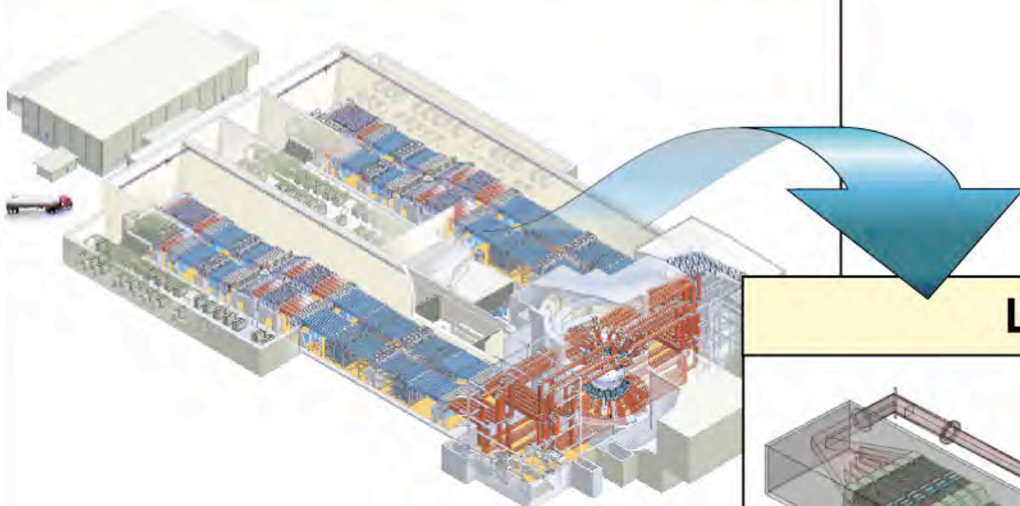


Assuming:
- **ID Fast Ignition**
  - **— G=200 @ 2MJ 0.5 µm**
- **Liquid 1st walls**
- **10 MW DPSSL**
  - **— 2MJ, 5Hz,0.5 µm, 15-20%)**

Is NIF a precursor to an Inertial Fusion Energy plant?

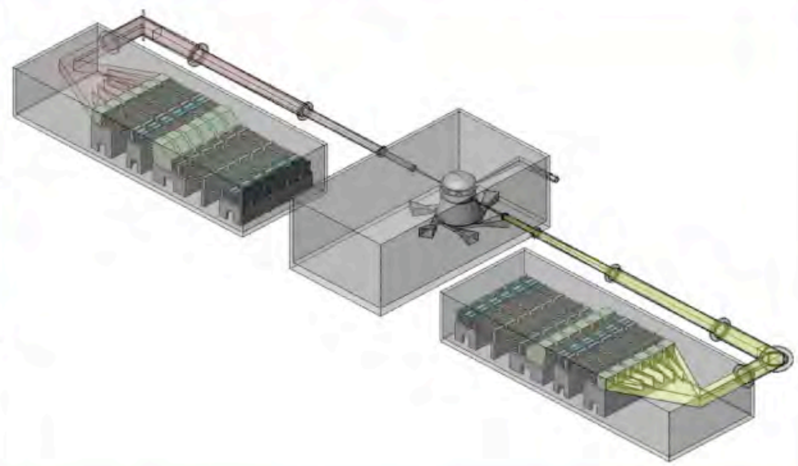
The National Ignition Facility

NIF (2 MJ)

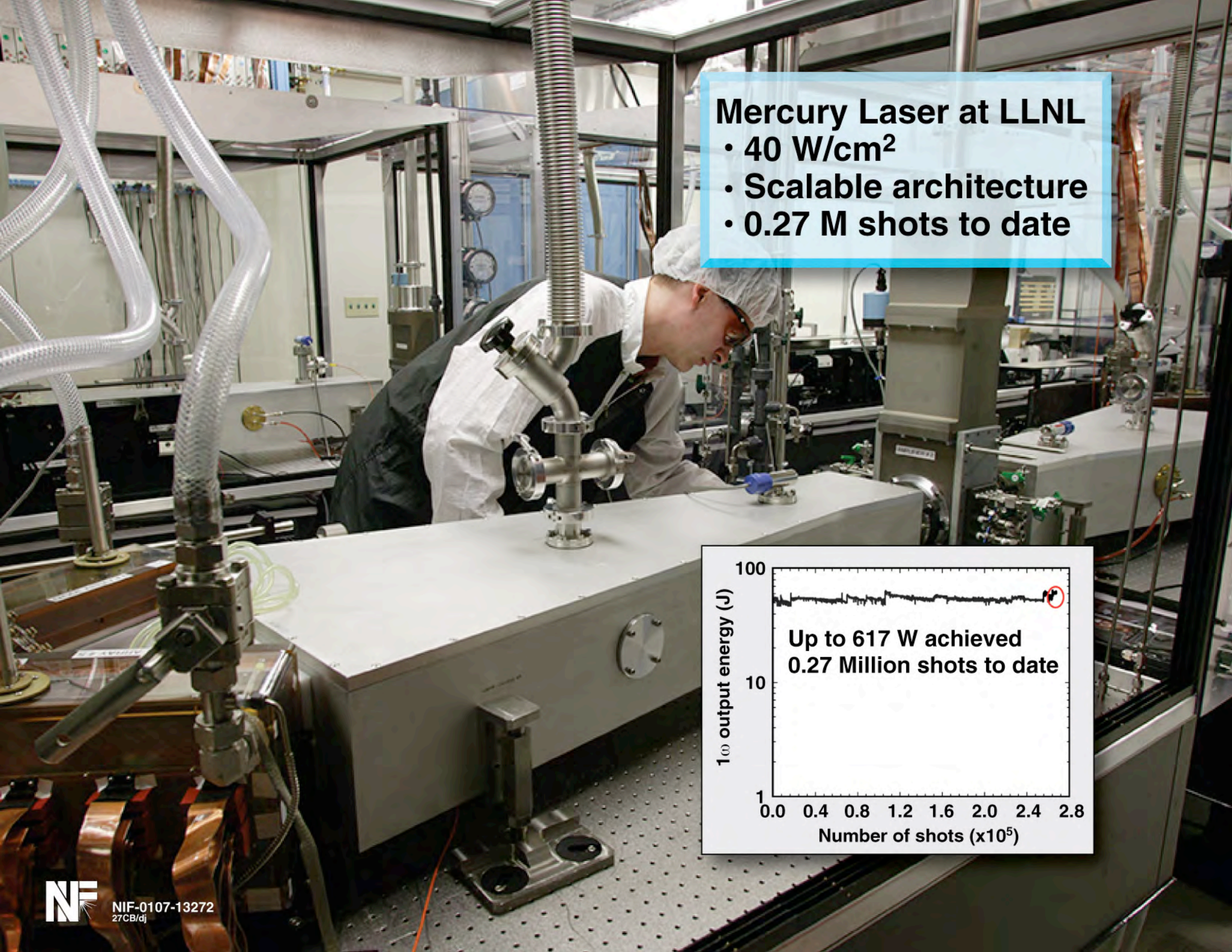


Repetition frequency 10-4 Hz
Electrical efficiency 0.5%

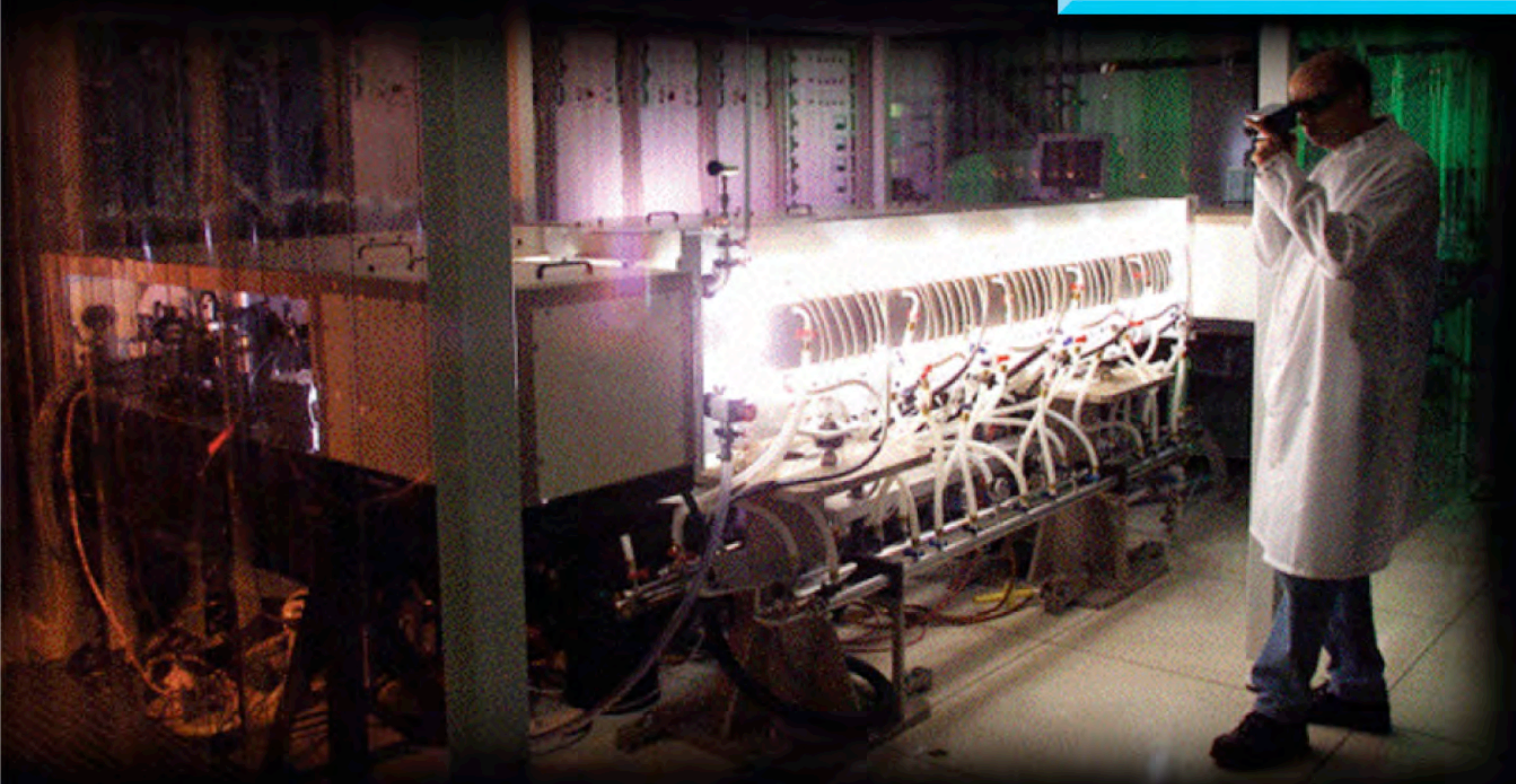
LIFE (20 MW)



Repetition frequency 5 Hz
Electrical efficiency 20%

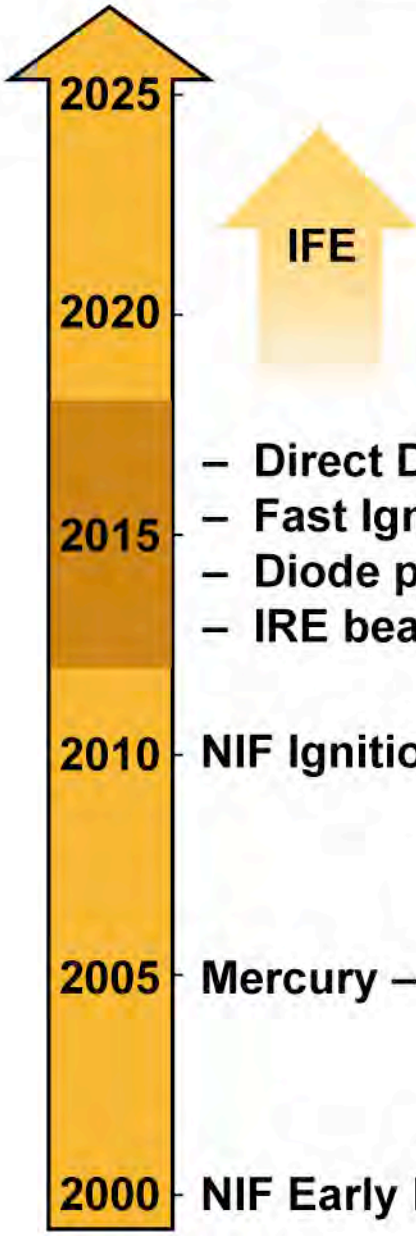

Mercury Laser at LLNL
• 40 W/cm²
• Scalable architecture
• 0.27 M shots to date
100
10
1
1ω output energy (J)
Up to 617 W achieved
0.27 Million shots to date
0.0 0.4 0.8 1.2 1.6 2.0 2.4 2.8
Number of shots (x10⁵)
NIF-0107-13272
27CB/dj

- LLNL/DOD 50 kW Heat Capacity Laser
- 10 x 10 ceramic Nd:YAG
  — 10 sec. burst mode operation
  — > 250 W/cm²



Leveraging the NIF provides a near-term pathway for fusion energy

The National Ignition Facility



- IFE Requires:
  - 20 MW laser power
  - 20% efficiency
  - 24/7 operation

- Direct Drive Ignition
- Fast Ignition R&D
- Diode pumped NIF beam line
- IRE beam line demonstration

NIF Ignition Campaign

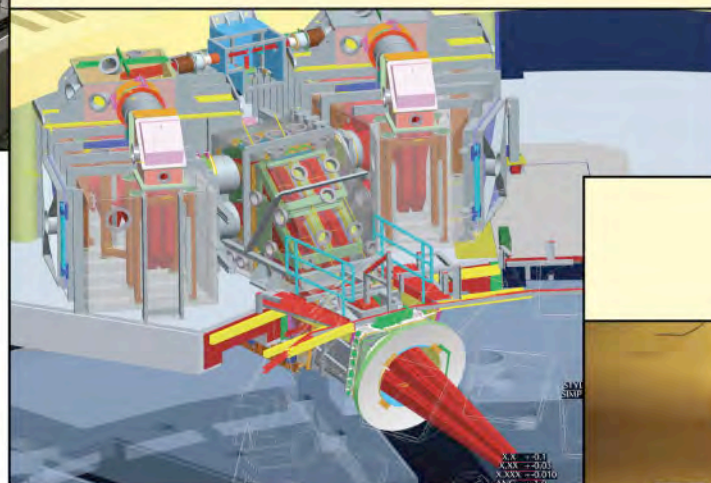
Mercury – 100 J/10Hz

NIF Early Light

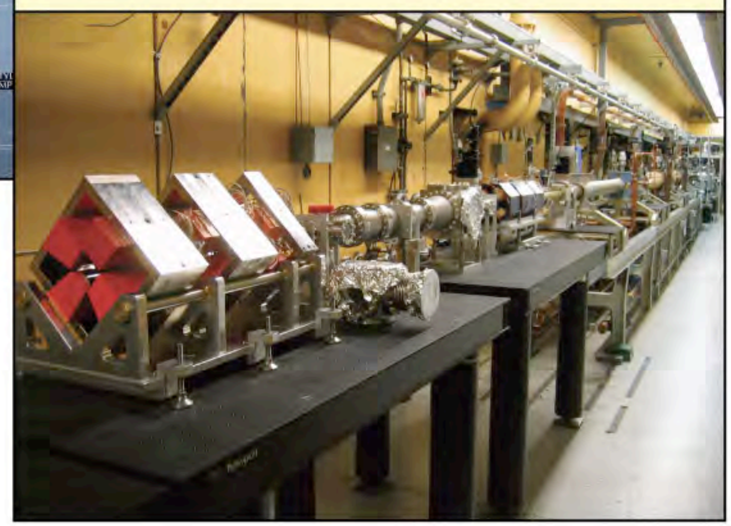
PS&A is the growth engine for the NIF Directorate

Average Power:
kW to MW

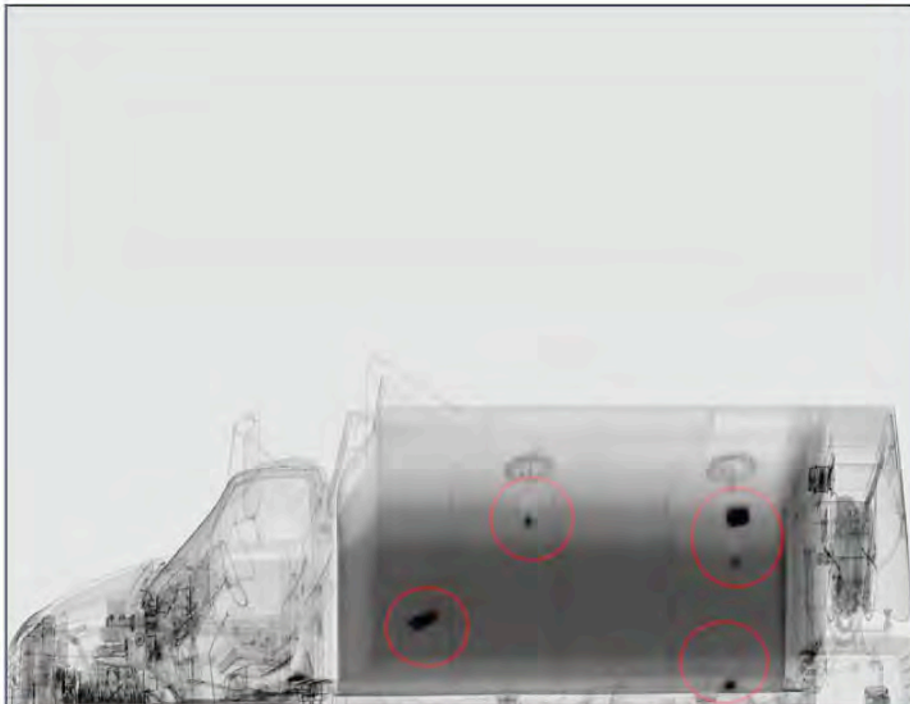
Peak Power:
Petawatts to Exawatts



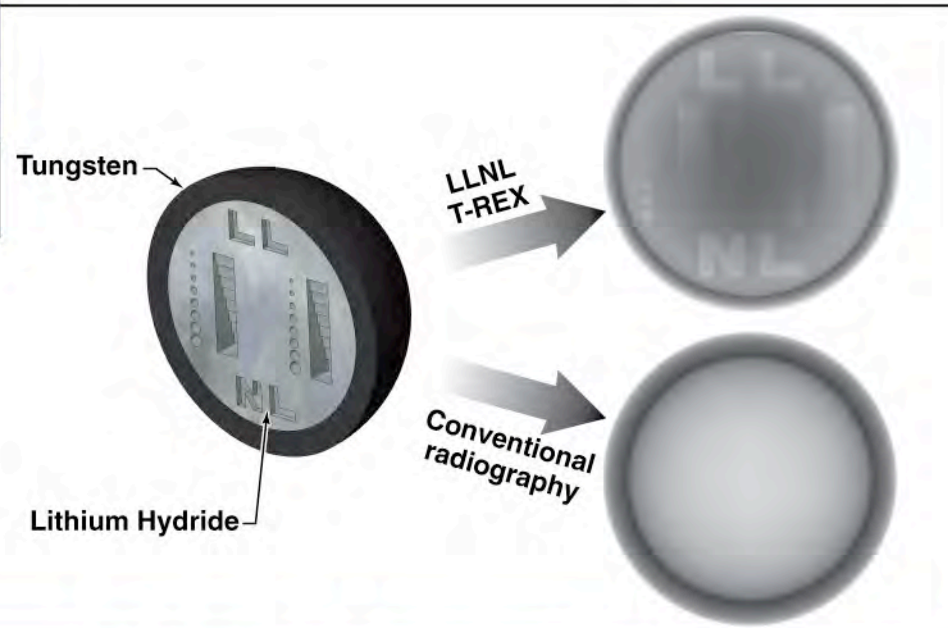
Photon Energy:
keV to MeV



Laser based gamma rays enable isotope imaging



Border Surveillance



Stockpile Surveillance

This capability is transformational Photon Science & Applications

NIF: Visions of yesterday become reality of today

The National Ignition Facility

1960's – Invention of Laser

2010 – Goal of Ignition

Ignition by 2010
Golden Anniversary of the Invention of the Laser and the ICF Concept

A glimpse into the future

The National Ignition Facility

From the Sun to the Sun

NATIONAL
IGNITION
FACILITY